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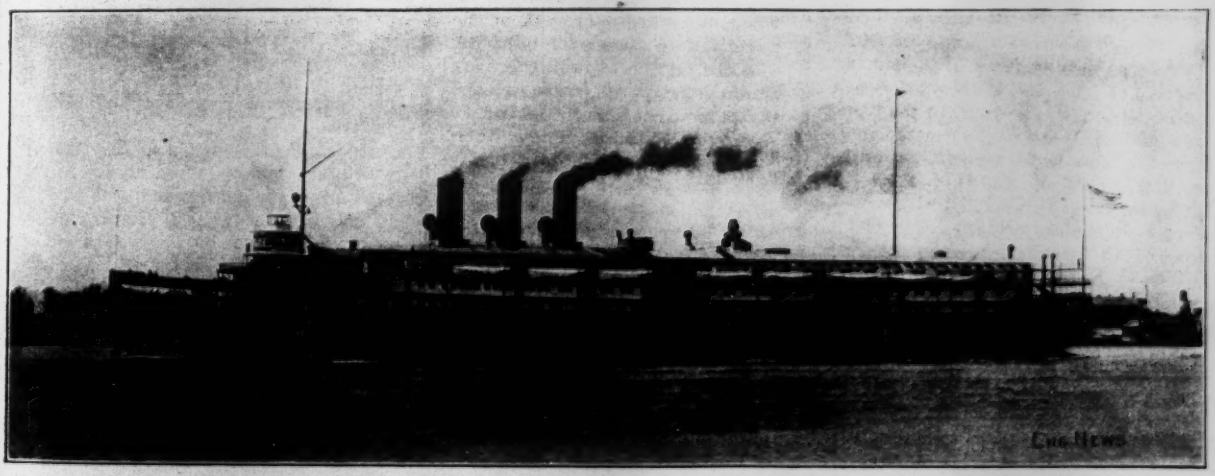
The Largest Side-Wheel Passenger Steamers on the Great Lakes

The side-wheel type of steamer still prevails to a large extent in the passenger service on the Great Lakes, and the accompanying cut represents what is said to be the largest steamer of its type on the lakes, if not in the world. This is the new steamer "City of Detroit III," which was put in operation during the past summer on the Detroit and Buffalo service of the Detroit & Cleveland Navigation Co. However, it will not long hold the record for size, since a still larger vessel is already under construction for another steamship line operating on Lake Erie. Both of these great steamers have been built by the Detroit Shipbuilding Co., of Detroit, Mich.



THE LARGEST SIDE-WHEEL PASSENGER STEAMER: "CITY OF DETROIT III": (DETROIT & CLEVELAND NAVIGATION CO.)

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Received Nov 4 1912

470-FT. SIDE-WHEEL STEAMER: DETROIT AND BUFFALO LINE

The "City of Detroit III" (whose name is decidedly awkward, although it may be historically interesting) is 470 ft. long over all, 455 ft. on the keel, 55 ft. beam of hull and 22 ft. deep. The width over the decks is much greater than that of the hull, extending to the outside line of the wheel casings. These casings are practically concealed and do not form a prominent feature of the vessel's design, as in many older side-wheel steamers.

The hull is of steel, with a double bottom, and is divided into compartments by ten transverse watertight bulkheads extending to the main deck. The double bottom is used for tanks for water ballast and to keep the vessel in trim, the tanks being served by pumps of large capacity. Amidships in the hull is an anti-rolling tank, the lateral movement of the water in this being intended to check the rolling of the vessel in rough water. There are six decks, two below and three above the main deck. A very complete automatic fire-alarm system is installed, and there are fireproof partitions and fire doors, while a sprinkler system is provided on the lower decks and certain other parts of the vessel. The general appearance is similar to that of other lake boats of the same class, with outside galleries at the upper decks, but there is the unusual feature of a set of three smokestacks. There are 600 staterooms, in addition to special cabins. The decorations are said to be unusually elaborate.

The wheels are of the feathering type, 30 ft. 3 in. diameter over the buckets, and each wheel has 11 curved steel buckets 14½x5 ft. The 25-in. crankshaft is driven by an inclined three-cylinder compound condensing engine, developing about 7600 hp. at 30 r.p.m. This engine is identical with that of a 400-ft. steamer built for the same line a few years ago. The high-pressure cylinder is 62x102 in., and on each side of it is a low-pressure cylinder 92x102 in. The cylinders are well lagged but are not steam-jacketed. The connecting rods are 25 ft. long between centers. There are six marine boilers carrying 160-lb. pressure and fitted with the Howden hot-air forced-draft system; they are arranged in three batteries, each having its own smokestack. The condensers are of the jet type. On the trial trip the vessel made a run of 133 miles at an average speed of 21 m.p.h. The ship and engines were designed by Frank Kirby, of Detroit, Mich.

500-FT. SIDE-WHEEL STEAMER: CLEVELAND AND BUFFALO LINE

As already noted, a still larger steamer of the same class is under construction and it is expected that this will be launched in October. This is for the Cleveland & Buffalo Transit Co., of Cleveland, Ohio, and will run between the cities of Cleveland and Buffalo. In appearance it will be similar to the other, but with the very unusual feature of having four smokestacks, and we believe it will be the first lake steamer to have this arrangement. This new vessel, which has not yet been named, will be 500 ft. long over all, 58 ft. beam, 96½ ft. wide over the guards, and have a displacement of 7700 tons.

The hull is of steel, divided into 12 compartments by watertight bulkheads, and having a double bottom extending over the entire length. The doors in the bulkheads are operated by hydraulic power, controlled from the engine room

There will be automatic sprinklers and an automatic fire-alarm system, and the kitchen or galley will be in a separate fireproof compartment. The ship will have 500 staterooms, accommodating 1500 passengers, and will have a total capacity for 6000 passengers and 1500 tons of freight. All rooms will be equipped with running filtered water, electric light and telephones; ventilation will be provided by fans delivering cooled air. The main saloon will be 400 ft. long, and the dining room will have a series of alcoves with bay windows so as to afford a good view from the tables.

As to the use of side wheels instead of screws for propulsion, the company states that the former system has been adopted as affording maximum comfort to passengers, although it is thought to cost more for construction and operation. The engine is of the three-cylinder compound inclined type, having a high-pressure cylinder 66x108 in. and two low-pressure cylinders 96x108 in. It will drive feathering wheels 30 ft. diameter over the buckets. At 30 r.p.m. the engine will develop about 9500 hp. and give a speed of about 22 m.p.h. The boiler equipment will include six single-end and three double-end marine boilers, each 14 ft. diameter, and these will have 24 furnaces 56 in. diameter. They will be arranged in four batteries, each with its own smokestack, the height from grates to top of stack being about 80 ft. The bunkers will have capacity for 600 tons of coal. There will be three turbo-generators, supplying current for fans, motors and over 5000 lamps.

For convenience and safety in the handling of so large a vessel in the harbors, the vessel will be provided with double rudders, one at each end.

A Great Reservoir of Oil Fuel

By David White*

When the rich deposits of iron ore have all been used up, the world will have to develop its stores of low grade ore, which are fortunately far more extensive than the high grade deposits. When the petroleum wells of the world fail to keep pace with the demand for liquid fuel, there are great deposits of carbonaceous shales from which oil fuel can be obtained by distillation. Such fuel will be much more costly than the present supply from oil wells; but the amount obtainable may prove a resource to the world when the coal beds are empty and the oil pools have been pumped dry.

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The problem of the fuel resources of the Devonian and Utica black shales is not so much a question as to the quantity of the shales as of the quantities of the fuel contained, and of the practicability of its utilization.

The Devonian black shale underlies portions of Iowa, Missouri, Arkansas, Alabama, Tennessee, Kentucky, Virginia West Virginia, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York; in thickness ranging from 25 ft. to many hundreds of feet. The Utica shale, which is generally much thinner than the black shale of the Devonian, is exposed over somewhat restricted areas of the northern Appalachian trough.

The amounts of organic matter contained in these shales varies from point to point, but the percentage is in general greatest in the regions where the shale is of moderate or even minor thickness. In portions of Michigan and Indiana the Devonian black shale is said to have sometimes been burned, being first ignited by some other fuel. It is stated, on the authority of Ohio River fishermen, that this shale, known in southern Indiana as the New Albany shale, has burned at its outcrop for a long time after ignition. On the shore of Sulphur Island, Monroe County, Michigan, where the shales are very strongly bituminous, beach fires are reported (Geological Survey of Michigan, Vol. VII, Part I, p. 26) to have burned in the shale as long as sixteen months.

Comparatively few analyses seem to have been made of the Devonian black shale on account of its relatively small percentage of organic matter. The following are given by Hans Duden in the 21st Annual Report of the Department of Geology and Natural Resources of Indiana, pp. 108-119:

I.

Water expelled at 100°C.	0.50
Volatile organic matters	14.16
Fixed carbon	9.30
Silica	50.53
[1]Pyritic iron and alumina	25.30
Calcium oxide	0.09
Magnesium oxide	0.12
	100.00

II.

Water expelled at 100°C., during four hours		0.56
Volatile organic matters	14.30	23.60
Fixed organic matters	9.30	
Silicates insoluble in HCl		65.43
Ferric oxide		8.32
Calcium oxide		0.09
Magnesium oxide		0.12
Sulphur		2.08
		100.00

[1]The amount of pyrite and alumina changes considerably in different layers. This piece had 10.367% iron pyrite and 14.933% alumina.

According to these analyses, the shale in the vicinity of New Albany seems not to contain more than 25% of organic matter. In his paper Duden describes experiments carried out by himself in retort treatment of the shales at various temperatures and determinations of paraffin and other products obtained thereby. When subjected to red heat in the retort, 8.5 lb. of black shale were found to yield 45 to 65 gal. of gas, as compared to a yield of 105 gal. of gas from 5 lb. of Pittsburgh coal. The shale gas is said to have burned with a light flame resembling petroleum gas light.

Mr. Duden prints a manuscript statement by the superintendent of the local gas company, New Albany, relating to experiments with the shales, with the object of commercial gas production. The shale was found to yield 2.2 cu.ft. per lb. of gas of 22 cp., the gas being, therefore, of better quality, though having but 45% of the yield obtained from Pittsburgh coal. The experiment which was carried on with apparatus suited to the use of Pittsburgh coal was judged a failure on account of the cost of fuel required to bring the bulk of the shales to the temperature necessary for gas production.

Duden found that by selecting retorts which insured a quick movement of vapors into the condenser it was possible to get, at a very low temperature, a great percentage of oil without much fuel expense. The crude oil was black, malodorous, and difficult to refine. By using a vacuum pressure of 15 in. he obtained a nearly colorless oil, without much smell. The quantity of ammonia naturally varied with the treatment. He says:

> Taking into consideration its thickness of more than 100 ft., the State of Indiana possesses in this Devonian slate a storehouse of power greater than the coal seams, which can furnish an almost inexhaustible supply of oils for illuminating, heating and other purposes, provided the proper methods of utilization are devised.

Samples of the black shale taken near Alpena, Mich., were found to contain 17.96% volatile matter; 6.49% fixed carbon; 77.55% ash, thus agreeing fairly closely with the New Albany shales as to total organic matter.

T. Sterry Hunt found the Devonian black shale at Bosanquet, on Lake Huron, to lose 12.4% by ignition in a closed vessel. No determination of the fixed carbon remaining in the black residue was made. Further description of Hunt's experiments and the products obtained will be found in his "Chemical and Geological Essays."

With reference to the native or free oil and gas content of the Ohio (Devonian)

shale in Ohio, Prof. Orton states that the amount of petroleum, "*existing as such* in normal samples," was found by Prof. Lord to be slightly less than one-fifth of 1 per cent., the larger percentages being found in the finer sediments. He adds (Report of the Geological Survey of Ohio, Vol. VI, 1888, p. 413):

> It was therefore certain that the true percentage exceeded that reported; further than this, there had, undoubtedly, been some loss of petroleum from the exposure of the shale, but even on the percentages obtained, if the shale series is counted at the low average thickness of 1,000 ft. for its entire area, the total amount per square mile passes far beyond the limits of clear comprehension.
>
> Calculations show that it would exceed ten million barrels (10,000,000) to the square mile, and such figures stand, of course, merely for numbers that turn up in arithmetical processes, but to which we are unable to attach any definite significance further than to recognize in them very large numbers.
>
> The oil stock of the shales is large, as thus appears, but the oil production is very small. The case, however, stands somewhat better with regard to gas.

The statements quoted above refer merely to petroleum and natural gas in a free state; not to the products of distillation of the shale. They touch the real problem but little.

Before the development of the Appalachian oil fields the richly carbonaceous shales of the Utica series were utilized for oil production in both the United States and Canada. For a number of years during the early part of the last century these shales are said to have been quarried and distilled in the vicinity of Utica, N. Y. On account of their black, highly carbonaceous character they attracted very much attention in eastern New York, and in those areas in the southeastern part of the state where the rocks have been subjected to greater metamorphism many of the thinner and very rich streaks developed an anthracite luster. The result was the expenditure, as narrated by Mather ("Geology of New York," Part I, 1843, pp. 393-396), in a number of counties of many thousands of dollars in exploration for anthracite coal. This region is, however, probably the least promising for distillation tests, since the more advanced degree of metamorphism has presumably caused the elimination of the greater part at least of the volatile in the shales. Speaking of the Utica shales, which in the period 1859-61 were used in Canada for the distillation of oils with a fair amount of success, as reported, Hunt remarks ("Geology of Canada," 1863, p. 784):

> These shales contain very variable amounts of combustible matter, and they give, when distilled, besides inflammable gases, portions of oily matter, which in the shales of Collingwood, the richest yet examined, are equal to 4 or 5%. Though the final results of the retorting of these shales are not now available the following details of operations at this place may be given:
>
> In 1859, works for obtaining these oils were erected on the locality of this shale, near the town of Collingwood. Twenty-four longitudinal cast-iron retorts were set in two ranges, and heated by wood; of which 25 cords are said to have been required weekly. The shale, broken into small fragments, was heated for two or three hours; from eight to ten charges being distilled in 24 hours. In this way it is said from 30 to 36 tons of shale were distilled daily and made to yield 250 gallons crude oil, corresponding to about 3% of the rock. By a further continuance of the heat, a small additional proportion of oil was obtained from the shale; but it was found more economical to withdraw the charge after 2½ hours.
>
> The bed of shale available for the purpose adjoins the works, and was furnished ready broken, at 20c. per ton. The cost of the crude oil from the shale was stated by the manufacturers to be 14c. per gallon. When rectified and deodorized, it gave from 40 to 50% of burning oil, and from 20 to 25% of pitch and waste, the remainder being a heavy oil fitted for lubricating purposes. After two or three unsuccessful trials, and the repeated destruction of the works by fire, they were at last, in 1860, got into successful operation, and a ready market was found for the oils.
>
> Data are, however, wanting to show whether the enterprise was remunerative; and it was after some time abandoned, partly, it is probable, on account of the competition of the petroleum of Enniskillen, which was about that time brought into the market in large quantities and at a very low price.
>
> Should it, however, at any time, be found advantageous to renew the experiment of distilling the bituminous shales of this formation, those of Collingwood offer very favorable conditions, from their accessibility, and also for the ready means of transport afforded both by the lake and the railway.

Hunt cites reports by Indians of the burning of the Utica shales in their outcrop along a shingle beach.

A sample of the Utica shale in Canada was found, by the Canadian Department of Mines, to give off 12.6% of volatile combustible matter, when ignited in a closed vessel, with a further yield of 8.4% of organic matter when calcined; and another yielded 23.7% of combustible and volatile substances, thus approximating the yield in the samples of Devonian shale from Indiana and Michigan already noted. Further details regarding the tests of the Utica shales will be found in Part II of the "Joint Report on the Bituminous or Oilshales of New Brunswick and Nova Scotia," printed by the Department of Mines, Canada, 1910 (pp 62-67).

Another more restricted source of shale-distillation products is found in the Platteville shale (Trenton group) in the zinc and lead district of southwestern Wisconsin and northern Illinois. Picked specimens, probably above the average, of this shale, which is locally known as "oil rock," are said to have revealed as much as 40% of carbonaceous matter; and material, presumably of exceptional grade, from the Dugdale prospect, west of Platteville, is said to have shown a content of 80.25% of volatile matter, with 7.95% remaining in the thoroughly dried shale. This rock is highly variable in thickness as well as in richness. Additional data, including a gas analysis by Rollin Chamberlin, of these shales, which are found mingled with the lead and zinc ores, and which were for a time experimentally used as fuels in the boiler room at one of the mines, are given in Bulletin No. 294 and Folio No. 145 of the Geological Survey. The boiler test was said to be unsatisfactory on account of failure to find enough high-grade oil shale in intimate association with the ores.

In this connection it may be noted that a sample of the Maquoketa shale from Carroll County, Illinois, has been found to contain 17% of volatile combustible matter, and 3.09% of fixed carbon in the air-dried sample. The Platteville oil rock and the Maquoketa shale are relatively thin and restricted in their geographic extent, as compared with the black shales of the Devonian and Utica.

Regarding the possible ultimate fuel value of the Devonian shale in Kentucky, Prof. N. S. Shaler ("Report Geological Survey of Kentucky," n.s., Vol. III, 1877, Part I, p. 80) said:

> It may not be out of place to call attention to the prospective value of this black shale as a source of future power to the Commonwealth. Its area in Kentucky is probably not less than 18,000 square miles, and its thickness may safely be averaged at 100 ft. Assuming that it contains, in the shape of free and combined oil, the equivalent of 15% of its mass, we see that it is equal to 18,000 square miles of oil 15 ft. thick. . . . Measured by the present price of the oil and paraffin it produces, this mass of shale might have been regarded in 1855 as overvaluing, by many times, the whole coal deposits of the state.
>
> At this rate of yield, there would be four million gallons to each acre of surface, and two thousand four hundred million to the square mile, so that the gross product to the square mile would, at the present price of these oils, have been something like a thousand million of dollars.
>
> The finding of flowing wells of light and of lubricating oils seemed to make this source of wealth that had dawned on the state sink into utter worthlessness. I doubt, however, whether we may not fairly look forward to this wonderful deposit of organic matter as a future source of varied and important chemi- the oil and the paraffin it produces, this the regions underlaid by it. There seems no room to doubt that the available areas of coal oil are being rapidly drained of their store, while the consumption grows apace. The natural resort will then be to these shales, which, even allowing that only one-tenth of the estimated quantity is available, will still be of far greater value than all the other known resources of the state.

In a later publication ("Man and the Earth," 1905, p. 40), Professor Shaler, calculating that the 100-ft.-thick Devonian black shale in Kentucky will yield to distillation probably one-tenth of its

mass in oil, paraffin, and related substances, adds:

> This oil and other burnable materials will be won at a much greater cost than where they are obtained from wells in the fluid state, but the by-products of the distillation to which the rocks are subjected, will probably be as valuable as those afforded by the natural oil. . . . . While the beds which may be distilled in order to obtain petroleum and its related products, are very extensive and widely distributed, we can not with certainty look to them as sources of power in most parts of the world until the coal beds are effectively exhausted. As a source of illuminating oils they are likely to be resorted to extensively in the immediate future, and to serve this use for centuries.

The moisture content of these black shales is very low, as might be expected of sapropelic deposits approaching so closely to the cannel coals in their origin and physical characters. The dark color of the shale is due to the content of vegetable matter. Most characteristic in the latter in the Devonian shale is the presence of innumerable numbers of small, thick (probably resinous or waxy) walled bodies, supposed to be megaspores, described by Dawson under the name *Sporangites*. The tests of the Devonian black shale seem not to have been sufficiently directed toward the quantitative study of oil distillation. Additional data regarding this matter are needed.

As to the enormous quantities *in toto* of the fuel stored in the black shales of the Devonian and Utica, there can be no question. The amounts may, on the whole, not have been over-estimated, although the analyses quoted were probably based on picked specimens gathered in rich localities; for while in many areas the shales are so lean in carbonaceous matter as not to have invited analysis, there are doubtless other points at which deposits considerably richer than those yet analyzed will be found.

The most difficult problem—the question as to what possible conditions may eventually bring about the successful commercial exploitation of these shales, as the oil fields become exhausted—will not be discussed here further than to state that David T. Day estimates that economic use can be made of some of the Devonian black shales as fuel when the price of kerosene reaches 20c. per gal. in bulk, or slightly more than double the present price, and gasoline reaches 40c., three times the present price.

It must be borne in mind that while the black shales, particularly those of the Chattanooga, New Albany, Ohio, and Genesee, appear to have qualities (presumably due to conditions of deposition and the nature of the ingredient organic débris) better adapted to the production of petroleum than most of the shales of the later formations, many of the latter shales are, however, far richer in organic matter and therefore of more value ton for ton as fuel resources.

The richest black shales and the impure or bony cannels, not to mention the so called bone accompanying many coals, though individually restricted as to geographic extent and relatively small in quantity, as compared with the Devonian black shale, will doubtless find earlier use, both for the combustion engine and for the production of illuminating gas and oils. Their greater ability to compete with the natural petroleum is shown by the fact that the plants distilling the carboniferous canneloid shales in western Pennsylvania and southern West Virginia were among the last to yield before the crushing competition of the oil-field petroleums and their byproducts.

In this connection mention may be made of the continued activity in the production of oil from shales of lower Mississippian age in Scotland, as recently described in the British Geological reports, and of the efforts of the government of Canada for the revival of the oil-shale industry in New Brunswick and Nova Scotia. The publications of the Department of Mines in Canada (see "Joint Report on the Bituminous or Oil Shales of New Brunswick and Nova Scotia; also on the Oil Industry of Scotland," 1909), and of the Geological Survey of Canada (the "Geology and Mineral Resources of New Brunswick," by R. W. Ells, 1907, pp. 108-114; Summary Report for 1908, pp. 134-142; Summary Report for 1909, pp. 200-216) contain full descriptions of the shale formations; of the analytical and other tests; of the method of extracting the oils, and of the production.

Most of the oil shales now under development in eastern Canada belong to the Albert shale group, which is probably at the base of the Carboniferous, corresponding in age to the oil shales of Scotland. The oil production from the Albert shales from a number of localities in New Brunswick was found to range from 35 to 65 gal. per ton, having a specific gravity ranging from 0.892 to 0.925, with sulphate of ammonium varying from 67 to 111 lb. per ton. The amount of organic matter varies widely with the sample. In the best grades it may comprise more than one-half of the shale. It is interesting to note that in the early days of the New Brunswick industry several thousand tons of the shale were brought to the United States for distillation.

Studies concerning the areal extent, thickness, distribution, conditions of deposition, and qualities of the Devonian black shales are now in progress in the U. S. Geological Survey. It is hoped that these inquiries may later be extended to other richly carbonaceous shales and sediments closely approaching coal or containing large quantities of combustible matter that may, under favorable circumstances, eventually be successfully made available for commercial use by some processes of distillation.

The Army of God-Knows-Where*

By ALFRED DAMON RUNYON.

Dedicated to our Civil Engineers.

No bands are playing gaily when they're going into action,
No crowds are cheering madly at their deeds of derring-do;
They are owing small allegiance to any flag or faction—
Their colors on the sky-line and their war cry, "Put it through!"

Ahead of bath and Bible and of late repeating rifle,
The flags can only follow to the starting of their trail;
They heard the leagues behind them, every mile the merest trifle;
They mark the paths of safety for the slower sail and rail.

Their standards kiss the breezes from the Arctic's cooling ices
To where the South Pole's poking out its new-discovered head;
You can see their chains a-snaking through the lands of rum and spices—
And East and West you'll always find their unrepining dead.

No time for love and laughter, with their rods upon their shoulders,
No time to think with vain regret of home or passing friends.
They are slipping down the chasms, charging up the mighty boulders,
The compass stops from overwork, the path-way never ends.

They slit the gullet of the earth; disgorge its hoarded riches
(But life's too short for them to stop and snatch a rightful share);
They've a booking on the Congo putting in some water ditches;
A dating to take tea with death, they make it by a hair!

You will find their pickets watching in the unexpected places;
You will hear them talking freely of The-Things-That-Can't-Be-Done;
Oh, the Faith they speak so strongly and Hope that's in their faces—
It lights the gloom of What's-the-Use as brightly as the sun!

No bands are playing gaily and no crowds are madly cheering;
No telegraph behind them tells their deeds of derring-do;
But forward goes the legion, never doubting, never fearing—
Their colors on the sky-line and their war cry, "Put it through!"

*Bohemian Magazine.

The Inadequacy of Exterior Fire-escapes was urged by H. F. J. Porter, fire expert and consulting engineer to the New York State Factory Investigating Commission, in testifying before the Commission on the subject of fire-protection. He claimed that this class of safety device was more a menace than a safeguard, due to poor construction, particularly in limited space. Mr. Porter, speaking from years of study of the problem, states that vertical fire walls with fireproof doors, and with ample inside staircases, are the best protection against loss of life by fires.

Costs of Leveling Ground with an Electric Drag Scraper

By James C. Bennett*

The gold-dredging industry of California has given rise to a method of leveling ground that offers possibility of a considerably more general application than has been developed to date. The method, by the electric drag scraper, was originated in the Oroville field, where one of the dredging companies was required by the municipality to restore to an approximately level surface the ground that it had dredged within the city limits. Although some such leveling had been done by means of horses and scrapers, prior to the development of the electric drag scraper, it had been on small tracts only, and the cost had been almost prohibitive when the acreage involved amounted to more than one or two, or possibly three, acres.

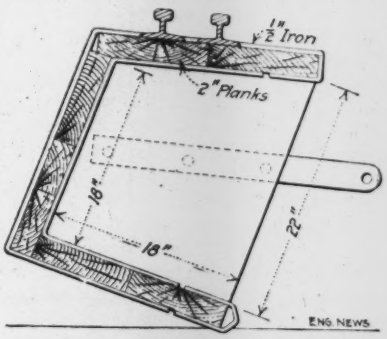
A few months ago, the writer was called upon to arrange for grading a piece of ground. The work involved leveling down some piles of gravel to a grade suitable for building lots, making a roadway 60 ft. wide by 600 ft. long, half the width being a cut and the remainder a fill, and filling a large water hole to a grade above the level of standing water. Practically all previous work had been done by owners on force account, and, since the only object to be gained was to level the ground to any convenient grade, no attempt had been made to determine the yardage involved, hence no unit cost was available. The nearest approach was based on the cost per acre, which ranged from $175 to $200 per acre. In this, however, it was impossible to secure any suggestion even as to the approximate yardage represented.

In preparation for the proposed work, an attempt was made to determine the approximate yardage involved by a rough measurement, but without success. Some idea may be gained of the difficulties of making measurements on ground of this character from the statement that, for purposes of railroad construction in this field, it was found necessary to make cross-sections at 10-ft. intervals. An estimate based on previous acreage costs would be unreliable in this instance, owing to the necessity of working to grade. The writer and the contractors made a joint estimate of the time required to do the work. As the approximate daily expense was known within fairly narrow limits, this afforded the most equitable basis of cost.

Seventy-five working days was agreed upon as sufficient time to complete the work. This was to include lost time on account of repairs, setting deadmen, moving lines and blocks, and moving machine from one position to another. During, and upon completion of the work, the following data were obtained:

Daily Expenses		
1 Winchman	$5.00	
2 Helpers @ $2.50	5.00	
1 horse (for moving lines, etc.)	1.00	
133.33 kw-hr. @ 2½c.	3.00	
Making a total daily cost of		$14.00
Time required		
No. days actually scraping	62	
No. days moving lines and winch and making repairs	10	
Making total days worked		72
No. working days in which no work was done	10	
Making elapsed working time days		82
Costs		
72 days @ $14.00	$1008.00	
Repairs, materials only	35.00	
4-horse team, man and scraper, surfacing street grade, 1 day	10.00	
600 ft. second hand, 1¼-in. hauling line	54.00	
600 ft. second hand, ¾-in. back line	30.00	
Depreciation at 10%	120.00	
Making a total cost of		$1257.00

In the foregoing figures as will be noticed, a charge is made against the job for the full cost of the ropes. In doing this, the job is being charged with a little more than is really legitimate, as the same ropes are good for probably two to three thousand yards additional. Also, the depreciation charge is probably liberal, as there is very little severe wear and tear on anything but the scraper.



Section through Bucket Used on Electric Drag Scraper

A close tally was kept of the number of trips made, or loads hauled, and, from time to time, the loads were measured. An average of 1¼ cu.yd. per trip is believed to be very nearly correct. The total amount of material moved, based on the number of trips made, was 15,300 cu.yd. The actual cost per cubic yard was thus 8.2c.

For the 62 days of actual scraping, the average running time was seven hours per day.

Average length of haul	175 ft.
Average day's duty	247 cu.yd.
Largest day's duty	425 cu.yd.
Average hourly duty	35.2 cu.yd.

The Equipment

The equipment consisted of a winch, motor, transformers, drag scraper, hauling and back lines, and snatch blocks. The winch was of the type commonly used on gold dredges, having been taken from a dismantled dredge. It was driven by a 50-hp. motor, through one belt and two gear reductions, giving a rope speed —both lines—of about 130 ft. per min. There was but one drum on the winch, having a central flange to separate the ropes. The hauling speed proved a very satisfactory one, but the return rope should have been speeded up to at least 150 ft., and possibly would have worked satisfactorily at 175 ft. per min. In fitting up the winch for the scraping work, the original cast-iron frame was discarded in favor of a much lighter timber frame, in which skids were made a part of the machine. For transmitting power from the transformers to the motor, an armored three-conductor cable was used. This permitted the winch to be moved about the field with its own power, and made unnecessary any moving of transformers. During the execution of the work, the winch was moved twice, that is, had three positions, including the original.

The transformers were not disturbed after being originally connected, as the nature of the ground permitted the selection of a location within reach of the several positions of the winch. The power company made no extra charge for running the necessary pole line—some five or six hundred feet—and connecting the transformers and motor.

The scraper was made of 2-in. planks, the cross-section being of the shape shown by the accompanying sketch. The inside measurements were 18x18 in. and it was 12 ft. wide. A little experimenting was necessary at the beginning of the work to determine the correct angle at which the bail irons should be set. It was found necessary to make one or two changes of this angle during the progress of the work, owing to different conditions of ground and material. The planks were well strapped together with bar steel, and the ends were of steel plate. One, and some of the time two, pieces of rail were fastened to the top of the scraper for added weight. Both hauling and back lines were second-hand mine hoist ropes, in very good condition, but discarded for mine use in compliance with state mining laws. With the exception of one or two small portions of the work, the hauling line ran over only one snatch block, while the back line ran over three blocks a large portion of the time. A fairly liberal use was made of deadmen, it being more economical than to move the winch.

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Ice Cream Diet for Panama Canal Engineers—During the fiscal year of 1911-12 the government ice-cream plant made 138,551 gal. of ice cream, valued at nearly $111,000. The demand for ice-cream grows steadily, and to insure the quality, fresh milk and cream are imported from the United States in refrigeration, for its manufacture. [Canal Record."]

Sanitation of Water Supplies*

BY PROF. WM. T. SEDGWICK, DR. A. C. HOUSTON, GEO. W. FULLER, DR. SAMUEL RIDEAL, M. DIENNERT, GEO. A. JOHNSON, PROF. G. GAERTNER AND RUDOLPH HERING.

The papers and discussions here presented deal with the sanitary protection of water-supply drainage areas, and with the principal means of water treatment now utilized, including sedimentation for clarifying purposes; storage for reduction of bacteria; filtration and disinfection by hypochlorites, by ozone and by ultra violet rays.

*Abstracts of papers and discussions before the International Congress on Hygiene and Demography, Washington, D. C., Sept. 24, 1912. Our abstract of Prof. Sedgwick's address, and of the discussions by Messrs. Diennert, Gaertner and Hering are based on notes taken at the Congress. The abstract of Dr. Houston's paper is a reprint of the official abstract supplied at the Congress. The other abstracts are taken verbatim from copies of the papers supplied to us by the authors. A report of the Congress appeared in our issue of Sept. 26, 1912.

Sanitary Control of Watersheds for Unfiltered Water Supplies

BY WM. T. SEDGWICK*

Many of the smaller water-supplies and some of the larger ones cannot be filtered or disinfected. It should be realized that even when the population on a drainage area is small the water from it is liable to pollution from hunters, fishers, trampers or loggers. As a safeguard the city or water company should own as much as possible of the drainage area and, however much or little it may own, it should clean up the drainage area and then keep it clean by sanitary inspection. Skating, boating and fishing should be prohibited.

In Massachusetts, cities and towns may apply to the State Board of Health for the establishment of rules for the sanitary protection of water-supplies [also in at least one other state—New York—ED.]. By this means and by long storage, Cambridge, Mass., has continued to use a surface water-supply from a well populated drainage area, without filtration, and has kept its typhoid rate to a low figure.

Purification of Water by Storage

BY DR. A. C. HOUSTON†

The purification of water by storage is discussed under three main heads: (1) Sedimentation; (2) Equalization; (3) Devitalization. The following comprise the chief conclusions so far arrived at:

(1) Storage reduces: (a) the number of bacteria of all sorts; (b) the number of bacteria capable of growing on agar at blood-heat; (c) the number of bacteria, chiefly excremental bacteria, capable of growing in a bile-salt medium at blood-heat; (d) the number of coli-like microbes; (e) the number of typical B. coli; (f) the amount of suspended matter, color, ammoniacal nitrogen and oxygen absorbed from permanganate; (g) the hardness.

(2) Storage alters certain initial ratios, for example (h), it reduces the number of typical B. coli to a proportionately greater extent than it does the number of bacteria of all sorts; (i) the color results improve relatively to a greater extent than those yielded by the permanganate test.

(3) Storage, if sufficiently prolonged, devitalizes the microbes of water-borne disease, e.g., the typhoid bacillus and the cholera vibrio.

(4) Storage has a marked "leveling" or "equalizing" effect.

(5) An adequately stored water is to be regarded as a "safe" water, and the "safety change" which has occurred in a stored water can be recognized and demonstrated by appropriate tests.

(6) The use of stored water enables a constant check to be maintained on the safety of a water-supply *antecedent* to and irrespective of filtration.

(7) The use of stored water goes far to wipe out the gravity of any charge that a water-supply is derived from polluted sources.

(8) The use of adequately stored water renders any accidental breakdown in the filtering arrangements much less serious than might otherwise be the case.

The Purification of Water from Standpoints Other than the Hygienic Aspect

BY GEORGE W. FULLER*

In addition to hygienic purity, a perfectly satisfactory water-supply should be of good appearance as to absence of mud, vegetable stain, grosser microscopic organisms, soluble and suspended iron; and it should also be free of offensive tastes and odors, excessive hardness and abnormal corrosive action on service pipes.

REMOVAL OF MUD OR TURBIDITY

PLAIN SEDIMENTATION—Fifteen years ago, or prior to the completion of the Louisville tests in 1897, the clarification of the muddy water which is so characteristic of the majority of American rivers was accomplished but partially if at all. Plain sedimentation when applied at its best ordinarily removed only 50 to 75% of the total suspended matter. With basins holding several days' supply, such as those at Washington, Philadelphia, Pittsburgh, Louisville, St. Louis, Kansas City, Omaha, etc., the effluent as delivered to the consumers contained for weeks at a time sufficient silt and clay to make it conspicuously muddy. At times the partially settled water contained several hundred parts per million of suspended matter.

STORAGE RESERVOIRS AND AVOIDANCE OF MUDDY WATER—In some instances the basins were large enough to serve as storage reservoirs from which the supply from the river was shut off at periods of very muddy water in the stream. This procedure was used to advantage for some years at Washington, Baltimore, Covington, York, and elsewhere. It is expensive and is seldom tried at present. When the river is muddy for a period exceeding the storage capacity of the basin, the benefit of the method not only fails, but the consumers may have to use muddy water for many weeks, diluted to a varying extent with clear water.

COAGULATION AND SEDIMENTATION—When coagulating chemicals, such as sulphate of alumina or sulphate of iron in connection with lime, are added to the water, it is possible to obtain a fairly clear effluent, provided a proper dose of coagulant is used with respect to quantity and quality of turbidity, and further provided that a period of one to two days or more is allowed for the particles of suspended matter to deposit upon the bottom of the basin. This method has been used at quite a number of places and is still in use at St. Louis, Kansas City, Leavenworth, Omaha, Nashville, etc. It is not wholly satisfactory as compared with the results obtained by filtration, as there is no ready way to correct the poor results obtained from an inadequate dose of coagulant and which correction is much more feasible when use is made of a filter plant. This method can scarcely be called for ordinary problems a complete and satisfactory solution of clarifying muddy water, although its favor has been enhanced somewhat recently in conjunction with sterilization processes, such as the application of hypochlorite of lime.

PLAIN SAND FILTRATION—Sand filters, when operated at fairly slow rates, say, from two to six million gallons per acre per day, are efficient in removing fairly

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coarse silt in quite large amounts. Fine clay particles, however, generally pass through the ordinary sand filter even when operated at rates much lower than what is called standard European practice, namely, 100 mm. vertical drop per hour, or 2,650,000 gal. per acre per day. Experience shows that when the unfiltered water contains for several days at a time more than about 30 to 50 parts per million of fine turbidity, the effluent is liable to suffer from deterioration in quality, not only as to its appearance, but also bacterially.

There are some exceptions to the rule, but generally speaking, sand filters outside of the New England states and some points along the Atlantic seaboard have not been successful in treating American river waters even after they are submitted to prolonged sedimentation. The only sand filter plant along the Mississippi River, for instance, at Rock Island, Ill., was abandoned some years ago and in its place was built a mechanical filter plant.

SAND FILTERS AIDED BY SEDIMENTATION AND COAGULATION—The feature which needs especial care is to see that the flocci of coagulated masses are removed from the water with sufficient care so that the surface of the sand bed does not become clogged too quickly. Ordinarily the water should undergo sedimentation for 18 to 24 hours before it reaches the sand beds. This feature adds to the cost of the complete method and in cases where insufficient coagulant is used there is some danger from serious clogging of the sand beds.

SAND FILTERS AND PREFILTERS—At present there are few or no instances where decided exception is taken to the use of coagulants. Experience has shown that it is safe and feasible to use them where there is intelligent management. Local custom and existing works, however, in some instances force a consideration of methods in which no use is made of these very helpful coagulants. This has led to efforts to clarify water by preliminary filters as well as by sedimentation before application to ordinary sand beds. This is the method in use at Philadelphia, Steelton, Wilmington, Albany, Montreal, and some other places. If the river water is not too muddy from fine turbidity it is of considerable aid. The method has decided limitations, however, in that at times of severe flood the percentage removal of suspended matter is least when it should be most in order to prepare the water properly for normal sand filtration.

In several instances coagulation is used in conjunction with some straining device, such as the practice at Steelton, and arrangements of this general order are now being installed at Pittsburgh to aid the local sand filters.

MECHANICAL FILTERS—Where coagulants are required, mechanical filters have rapidly come to the front during recent years. They have been installed or have been recommended for use at nearly every [new ?] plant of considerable size, outside of the New England states, during the past few years.

This type of plant ordinarily operates at the rate of about 2 gal. per sq.ft. per min. When the water is properly coagulated such filters may satisfactorily perform at rates from 25 to 50% in excess of this rate. Such devices deliver a water of excellent appearance and under proper supervision they are substantially as efficient as sand filters in securing bacterial removal. These plants have recently been built with concrete tanks and hydraulically operated gate valves to control the operation of the plant, as well as automatic appliances to insure a *pro rata* application at all times of solutions of chemicals to the varying volume of water to be filtered.

Mechanical filters have been installed at Little Falls, New Milford, Louisville, Harrisburg, Cincinnati, Columbus, Toledo, New Orleans, and at some 300 smaller plants. This type of filter constitutes the characteristic method now in vogue in America for insuring a well clarified water-supply from the ordinary American rivers which are highly charged with silt and clay. Undoubtedly it is the most efficient and economical arrangement for the majority of American water-purification problems outside of certain areas along the Atlantic seaboard.

COLOR REMOVAL

For many years it has been known that ordinary sand filters will remove from 25 to 35% of the color or vegetable stain from the applied water. Such results have been obtained at numerous places in New England. It has been the endeavor in solving many American problems to secure filtered water that does not contain more than about 10 parts per million of vegetable stain as measured by the platinum-cobalt standard. This is approximately the dividing line above which the color becomes readily noticeable to the consumer as seen in a glass upon the table and especially in a porcelain bath tub. Where sand filtration will not allow a result as good as or better than this to be obtained, there has been an effort in a number of places to employ coagulants and thus take advantage of the discolorizing effect of sulphate of alumina. This is an important factor which was considered in arriving at the recent determination in New York City to employ coagulation and mechanical filters for the treatment of the present water-supply from the Croton watershed supplying the old city of New York. Sulphate of iron and lime do not give ordinarily a satisfactory color removal, as demonstrated at Toledo and elsewhere.

In some cases intermittent filters, as at Ludlow reservoir, Springfield, Mass., have aided in bringing about an unusually high removal of color. This seems to be due in part to an anaërobic decomposition having taken place in the water before its filtration. The color unites with iron in the water and is precipitated upon aëration. Another interesting feature that has been established at the new filter plant at Springfield is that when the coagulant is applied as an overdose to a part of the water to be treated, it is said that the mixture of the entire mass of treated and untreated water is decolorized to a greater extent by the sulphate of alumina than would be the case if the same quality of coagulant were to be applied at a uniform rate of dosing to the full volume of water delivered to the purification works.

When the water to be treated contains varying high amounts of both mud and color much care is required in adjusting the required dose of coagulant to the composition of the water.

MICROSCOPICAL GROWTHS

Some years ago an unusual effort was made to prevent the appearance in water supplies of microscopical growths of algæ and other organisms larger than bacteria for the sake of minimizing their influence upon objectionable tastes and odors. In some instances, particularly in Massachusetts with unfiltered supplies, the bottom and sides of impounding reservoirs were stripped so as to obtain in the exposed surface soil only a small quantity of organic matter. This practice has not recently been followed for the large reservoirs for the new water-supply of New York City, or elsewhere, particularly if the impounded water is muddy at times. It is considered better to aërate and filter the water to correct the unfavorable influence of these growths rather than to try to prevent them.

Microscopic growths have been killed in a large number of instances in America through the use of copper sulphate and to some extent by the use of hypochlorite of lime. The latter seems to have certain limitations and is not in such general use as copper sulphate.

Filters incidentally serve for the removal of microscopic growths. In some instances certain types of filamentous growths are likely to give trouble due to filter clogging. At Cincinnati experiences of this kind have been encountered and aid has been secured through the application of hypochlorite to the unfiltered water. It is a style of problem that requires special treatment in most cases.

TASTES AND ODORS

Many surface waters, particularly those which are not turbid, contain at times objectionable tastes and odors. The latter are sometimes due to growths of organisms themselves. In other cases they are due to the disintegration of the organisms and to the liberation of certain oils which

are very penetrating in their nature. Still other objectionable tastes and odors are found in waters that have undergone anaërobic decomposition which causes offensive gases to be liberated.

Aëration is a great help in the removal from water of these properties which produce objectionable tastes and odors. Combined with filtration, either mechanical or sand filters, there is obtained the most practicable method of securing a satisfactory water as to freedom from tastes and odors. It is one of the characteristic features of the new Catskill supply for New York City, and is being carefully considered as an aid to the filters for the Croton supply of New York.

Iron Removal Plants

There are half a dozen plants in America mostly of small size where ground waters are aërated in order to precipitate the iron and then the settled water is applied to filters. Most of the earlier filters were of the sand-filter type, but a few recent ones have been of the mechanical type. It is not a line of water purification upon which there is much experience in America as compared with Germany.

Water Softening

The large water-softening plant at Columbus and three or four smaller plants provide the experience up to this time in the softening of municipal water-supplies in America. Many of the railroads and industrial concerns take advantage of water softening in securing satisfactory water for boiler and manufacturing purposes. Throughout the West very hard water-supplies are to be found, and even in the Great Lakes district the water is much harder than it is along the Atlantic seaboard. The cost of softening very hard water-supplies has undoubtedly been a factor in retarding developments along this line. Experience has shown, however, that it is a perfectly feasible matter to soften the western waters if it is so desired.

At Grand Rapids, Mich., a mechanical filter plant is approaching completion that is to be used in conjunction with a softening plant. This plant will remove mud and vegetable color from the Grand River water and reduce its temporary or carbonate hardness by perhaps 50%, so that it will equal what is called locally the "Lake Michigan standard." The total hardness of the softened and filtered water will be approximately 125 parts per million. The reduction in hardness will be effected by lime without soda.

Corrosion of Pipes

Service pipes, particularly those of galvanized iron or wrought iron, are more liable to corrosion with filtered water water than with unfiltered water. In part this is due to the elimination of substances, such as silt and vegetable matter, which retard in a physical way the rate of corrosion, and in part it is due to an increase in carbonic acid, which in the presence of oxygen is a very prominent factor in influencing the total amount of corrosion, the rate of corrosion and the amount of dissolved iron which may be present in water as drawn from the faucet, and is thus the principal feature of unsuitability from the standpoint of iron stains. It is scarcely feasible to remove the oxygen present in water and, in fact, aëration tends materially to increase the oxygen up to the limits of the saturation point of this gas.

Carbonic acid seems to be the principal feature related to the speed and amount of corrosion of iron by filtered water. Where coagulants are used there is a corresponding increase in amount of free carbonic acid. This has led some people to consider this feature as quite a drawback to the use of coagulants. It has been studied recently in New York City from the chemical viewpoint with much thoroughness. The conclusion has been drawn that it is feasible to control the amount of carbonic acid through the proper addition of lime or soda. This feature will be an interesting part of the new Croton filter plant.

With hard waters in the South and West there has been comparatively little or no difficulty as regards corrosion of pipes by filtered water. The problem, therefore, is related more particularly to the soft waters along the Atlantic seaboard.

General Considerations

Speaking generally, water purification as relates to filtration is on a thoroughly well established basis in America. The features that differ most essentially relate to preparatory treatments rather than to material differences in designs either of sand filters or of mechanical filters. The use of chemicals for purposes of coagulation and softening has been studied in the last few years with considerable thoroughtness and the problem is one that is so related to the influence of local details that each project should be carefully studied on its own merits rather than to attempt to copy blindly the style of works which may be in successful use elsewhere.

More than ever before it is now realized that the successful methods of water purification should receive intelligent management and this is particularly the case where the type of water calls for the use of coagulating chemicals.

Water Disinfection by Chemical Methods

By Samuel Rideal*

To work with economy, water which is to be disinfected chemically should be at least roughly filtered beforehand, in order not to waste the reagent on such matter as can easily be separated mechanically. The introduction of mechanical filters has made the operation comparatively simple, and enables necessary chemicals to be added under control. It has been pointed out that the unstable yet powerful bacterial toxins are not likely to be destroyed by the comparatively mild oxidizing agency of the mechanical filters or even by the sand filters in the winter. They are removed, neutralized or destroyed, however, by the best methods of chemical sterilization.

A condition of drinking-water sterilization is that no substance should be left behind which can in any way be injurious to health, and if possible that nothing extraneous to the water should remain. It is at the same time a disadvantage if a disinfectant, however powerful in its first onset, is very evanescent, as many disease germs are strongly resistant, and we know that the time factor is of extreme importance in sterilization. In the first of these conditions

Ozone suggests itself as an ideal, producing nothing by complete oxidization of organic matter but carbonic acid and water, while the combined nitrogen is partly liberated in the free state and partly oxidized to harmless nitrates, and the organic sulphur and phosphorus give equally innocent minute quantities of sulphates and phosphates.

Ozone is now rather extensively used in Europe for sterilizing partially purified water. In 1908 I was called upon to examine the De Frise system at the Paris waterworks of St. Maur and found very successful results. The river Marne water, after ordinary sedimentation and filtration through gravel and sand, was still unfit for a supply, but by afterward ozonizing it gave a well aërated brilliant liquid of natural bluish tint and quite inodorous, containing per cubic centimeter only 1 or 2 innocuous organisms of the subtilis type. The coli test became invariably negative, although altogether 1580 c.c. were examined, with a maximum of 200 c.c. at one test. I found that 57 kw.-hr. per million imperial gallons were required for the sterilizing operation and 76 kw.-hr. for pumping. These figures would be reduced to 47.5 and 63.4 kw.-hr., respectively, per million U. S. gallons.

The De Frise apparatus used Siemens-Halske oxonizers with a simple and efficient ozonizing tower and a circuit by which ozone escaping after action was returned and used again, thereby effecting an important economy. The Paris municipality decided in July, 1910, that the part of the city drinking supply derived from the Marne, about 24,000,000 [U. S.] gal. daily, should, after coarse filtration, be sterilized by ozone, half by the De Frise and half by the combined Otto process. The latter employs "emulsers," which are injectors effecting a mix-

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ture of ozonized air with the water, the action being completed in "columns of self contact."

Ozone sterilization has been installed in about 30 French towns, in Roumania for the Danube, at St. Petersburg for the Neva at two water-works, in Holland (the pioneer), Belgium, Germany, Italy, Spain, Brazil and Egypt, and experiments have been undertaken at Darjeeling in India, while an installation is in course of construction at the Knutsford water-works, Cheshire, England.

Other processes differing in mechanical details are the Vosmaer, tried at Philadelphia, and the Howard-Bridge, at Lindsay, Ont.

The largest plant at present is that at St. Petersburg, Russia, for 1,000,000 [Imp.] gal. per day. The water is first treated with sulphate of alumina, then passed through 38 sand filters at a rate of 1000 gal. per sq.m. of filtering surface per hour, and then enters the five sterilizing towers along with ozonized air. There are 128 Siemens-Halske water-cooled ozonizers. The air is freed from moisture by refrigeration and is ozonized to the degree of 2.5 grams per cu.m. The total cost from the raw river to the finished water was recorded in 1911 as 0.86 to 0.97d. per 1000 gal. At St. Maur, Paris, M. Colmet Daage estimated that the cost, under the most favorable circumstances, was 0.31d. per 1000 gal., excluding interest, amortization and repairs. At Nice, where cheap water power is available, the average last year was given as 0.164d. per 1000 gal., and at Rimiez, where there is besides no pumping, it was only 0.125 d.

The preference for ozone as a water-sterilizing agent has been hindered by several difficulties. One is the question of expense: in this regard the manufacture has been considerably cheapened. Another is that it has to be applied in the gaseous form diluted with air so that a large quantity of inert gas must be pumped and the ozone with this admixture does not very readily dissolve: the latter fact has been overcome by using towers and saturators as mentioned above. Moreover the conversion of oxygen into ozone is a reversible action, requiring a number of precautions as to detail. In spite of the numerous researches, the best conditions are not yet fully agreed on, therefore we have not reached finality in the economy of ozone production. It is stated that "the best results ever obtained with a silent discharge apparatus gave 36.7 grams of ozone per kw.-hr., the theoretical yield being over a kilogram." A certain amount of the loss is due to the formation of ultra-violet light in the machine. When an ozonizer is acting properly, the inter-electrodic space has an almost uniform violet illumination, without any sparking. Regener (Ann. d. Physik, ix, 1033, 1906) showed that the presence of ultra-violet light limits the concentration of ozone within certain limits, above which it exercises a de-ozonizing effect. These rays are well-known to have also a sterilizing action, and my son, Eric K. Rideal, has devised an apparatus in which both activities are utilized (English patent 18,680, of Aug., 1910).

Siemens & Halske have several devices for preventing corrosion of the metallic parts of the apparatus. British patent 17,787, of 1910, reverses the usual procedure by drawing ozonized air through the water, instead of forcing it through from below, so that the main work shall be done, and the ozone almost entirely used up, before entering the pumps. This appears expensive mechanically. Their French (International) patent 431,402, of 1910, introduces small quantities of water to the pumps at the same time that the gas is admitted.

CHLORINE sterilization is effected in practice by means of hypochlorites, prepared either chemically or electrolytically. It will be well known to you that "chemical chlorine," chiefly chloride of lime, is largely used in America. It is also employed at some places in Europe and in India. After three noted epidemics of typhoid in England, chloride of lime was used at Maidstone for disinfecting the mains, pipes and reservoir; at Lincoln for the city water-supply, and quite lately for the same purpose at Cambridge. At Johannesburg the Witwatersrand supply is sterilized by the addition of chloride of lime equivalent to 0.25 to 0.5 parts per million of available chlorine (Leitch, *Proc.* Inst. C. E., London, 1911).

The objections to the lime compound are avoided by electrolytic hypochlorite, which, having soda as a basis, only leaves behind an unimportant residue of common salt, and slightly softens the water, besides having apparently a somewhat greater bactericidal effect. The addition of 1 or 2 parts per million of "available" or "active" chlorine, which is all that is generally needed, does not affect the taste, and even where a water is excessively polluted, and more is necessary, the product is even then not brackish like many present supplies. I first began trials on a large scale at Maidenhead, England, in 1898, and found that 17 parts per million of available chlorine killed in 15 minutes all the organisms in a filtered sewage effluent entering the Thames. In 1904, at Guildford, I observed that with 2.5 parts per million tertiary effluents were practically sterilized, in fact were purer bacterially than the town water-supply. I next tried experiments on the latter, which contained 90 organisms per c.c. with coli present in 4 c.c. After treatment with 0.75 part per million of available chlorine the total organisms were reduced in 5 hours to 14 per c.c., and coli was absent from 20 c.c. A portion purposely infected with 100 coli per c.c. was treated with 0.8 part per million of available chlorine, and after one hour's action there were no coli present in 20 c.c., and this condition remained for a considerable distance in the channel. Since then I have been directing the application of chemically prepared sodium hypochlorite to 100,000 Imp. gal. daily of the drinking-water supply of a North of England town with success, in the proportion of 1 to 2 parts available chlorine per million. Practical sterility is attained, there are no coli in 75 to 85 c.c., and the taste is not affected.

Not sufficient notice has been taken of an explanation I gave in 1909, at the Leeds Health Congress (*Jour.* Royal San. Inst., London, xxxi, 2) of the fact that with hypochlorites the first rapid consumption is succeeded by a slower action, which continues for some hours or even days to favor sterility. It is due to the formation by the action of chlorine on ammonia and nitrogenous organic matters, of strongly germicidal compounds, chiefly chloramine (NH_2Cl) and hydrazine (N_2H_4). These in the traces present are not injurious to higher animals, and soon disappear. The removal of any residual traces is hastened by cascades, which have also been used with success in ozone treatment.

A great advantage both of the ozone and chlorine processes is that they can be so easily controlled by the starchiodide test. It is sufficient to observe that the reagent is faintly blued by the treated water to insure adequate sterilization. Systematic testing in this way avoids the risk of underdosing or overdosing, and does away with the need of removing any excess of the sterilizing agent by a secondary treatment, such as the addition of sulphites, or filtration through "prepared charcoal" or iron turnings and sand: processes that increase cost, time and space required. I have found that if the process is controlled as above, without such further treatment the water usually becomes free from odor and taste in 1½ hr.

The cost of chlorine sterilization will obviously depend greatly among other things on the price of materials. If one part per million of available chlorine be required, and if its cost be about £14 per ton when derived from chloride of lime, and £21 per ton when made as sodium hypochlorite (*Jour.* Soc. Chem. Ind., Jan. 31, 1912), this item alone will reach 0.014d. per 1000 gal. of water in the first case, and 0.022d. in the second. The lime compound is more suitable for sewage than for drinking water, since it increases the hardness and affects the taste. There is for many reasons an advantage in making sodium hypochlorite electrically at the water-works, especially if cheap power is at hand.

The "Ferrochlor" (Duyk) method adds about 8 parts of ferric chloride and 0.2

parts of available chlorine as bleaching powder per million gallons of water to effect coagulation and sterility. One objection is that it is advisable to do all coagulation and sedimentation before sterilizing, in order to avoid re-contamination.

THE EXCESS LIME METHOD—In a report of February, 1912, Dr. A. C. Houston [Chemist Metropolitan Water Board, London, England—ED.], after investigation, proposes an "excess lime" method founded on his observation that "quicklime (about 75% CaO) added to raw Thames water in the proportion of one part of this quicklime to 5000 parts of water kills B. coli in 5 to 24 hr. . . . and inferentially, but certainly, the microbes also of epidemic water-borne disease, e.g., the typhoid bacillus." The excess of free lime is to be then neutralized by one-third of the volume of "*adequately* stored water," which must, of course, be previously examined. [See this journal of June 6, 1912, p. 1087, for details of the Excess Lime System.—ED.]

This is one way of chemical sterilization which has been often tried: the attraction being the cheapness of lime and also the softening effect on the water. It is really, however, an expensive one, on account of the amount of lime needed, equal to about a ton [2240 lb.] per million [Imperial] gal., and there is the need to test the water both before and after the process, and in addition the difficulty of getting rid of the huge deposit of carbonate of lime formed.

COPPER SALTS—As to copper salts, you are more familiar with their use in America than we are in Europe. Employed in rather large proportion, they kill objectionable algæ, but are not much good against bacteria. A fault is the immediate precipitation of the copper salt by the natural carbonate of lime in the water, and although an insoluble copper salt can act germicidally, as proved by the use for Phylloxera, the action is local and irregular. The application has been expensive, by towing boats over the reservoir with bags of sulphate of copper, and it is very difficult to make it uniform. Subsequent filtration is necessary, and there is a chance, even then, that traces of copper may remain in organic solution, so that it is fortunate that there are safer methods.

Water Disinfection by Ozone, Ultra Violet Rays and Chlorine Compounds*

BY M. DIENNERT†

Plants for treating water by ozone need constant supervision as to the quantity of water being treated, the quantity of ozonized air and both its ozone and nitrous contents, and as to humidity and temperature. Ozone most nearly fulfills the standards set by the author for water disinfection.

Ultra-violet ray experiments have not given so satisfactory results as ozone.

DISCUSSION

By request the discussion was opened by George A. Johnson, whose formal or written remarks on water disinfection have been condensed as follows:

OZONE — Unquestionably the main weaknesses in the ozone treatment of water lie in the difficulty of constantly effecting a perfect mixture of the ozonized air with the water; failure of the producers to yield without interruption a constant quantity of ozone; and, finally the cost of the treatment. It is true that during the past few years there has been marked improvement both in the apparatus and in methods of mixing the ozonized air with the water, and it may be that in the not far distant future the ozonization of water for sterilizing purposes will be found practicable from standpoints both of efficiency and cost. It is to be admitted, however, that in view of the results which have been obtained thus far the prospects in this regard are not particularly alluring.

COPPER COMPOUNDS have received a great deal of attention during the past ten years, particularly as destroyers of objectionable algæ; but their use in water-purification practice for the destruction of pathogenic bacteria is not now looked upon with favor, except by a limited few. Aside from questions of cost there is the as yet unanswered question of whether these compounds, used continually in the quantities required for the effective destruction of pathogenic bacterial life, do not leave behind objectionable substances which may even be classed among the accumulative poisons. This latter point, more than anything else in all probability, appears to have served to relegate copper salts to the background as effective and harmless germicides in the sterilization of public water-supplies.

THE "ULTRA-VIOLET RAYS" method promises much, but is still in the experimental stage.

HYPOCHLORITE DISINFECTION—We now come to a process which, in the past four years, has been shown to be markedly superior to any other in the sterilization of large public water-supplies. This is the so called "chlorine process," in which hypochlorite of lime in the form of a powder, or hypochlorite of soda in the form of a liquid, is used.

The points in favor of the process lie in its ease of application; the quick germicidal action of the chemical; the selective action of the chemical in that the pathogenic germs are among the first to be destroyed; the entire absence of poisonous features, there being left in water treated with hypochlorite no substances which are deleterious to the consumer; and, finally, the low cost of installation and operation of the necessary works.

The hypochlorite treatment has its limitations, of course. It cannot be considered as a substitute for filtration, for, with the quantities ordinarily used it has no material effect on the chemical or physical qualities of the water. Its value lies wholly in the fact that it destroys pathogenic bacterial life. When used in connection with water filters as a final "polisher" it insures the removal of the last vestige of potential danger which the water may possess after filtration. Whereas the filtered product, while clear, colorless and otherwise physically and chemically satisfactory, may, at times, contain a small number of pathogenic germs, these are quickly and permanently destroyed through the agency of a small amount of hypochlorite applied to the filtered product.

Speaking very broadly, filters thus become water clarifiers, and the hypochlorite treatment is used to insure high bacterial purity coincident with the destruction of disease germs. Being used substantially as water clarifiers the filters may be run more cheaply. Less coagulating chemical is required since high bacterial efficiency on the part of the filters is not absolutely essential. Where waters are heavily burdened with algæ growths, the use of small quantities of hypochlorite will destroy such growths and make it possible for the filters to run longer between necessary cleanings. Such was the experience at Cincinnati. Finally the use of hypochlorites in connection with water filters results in a feeling of complete security, and the consumer rests confident that he has been furnished with water, not only satisfactory to the eye and taste, but also free of pathogenic germs at all times.

The particular adaptability of the hypochlorite treatment is not only in connection with water-filtration plants as above outlined, but also in the sterilization of waters which are normally clear, but which contain pathogenic germs. This refers to lake waters as distinguished from turbid river waters, and to clear-water brooks flowing through inhabited water sheds, and to impounded supplies. It has a field of usefulness in the temporary treatment of turbid and colored waters until such time as permanent filtration works can be built for the removal of this color and turbidity.

As stated before, hypochlorites are obtained in the powder form, if in the form of hypochlorite of lime, or in liquid form as hypochlorite of soda, the same being produced electrolytically by subjecting solutions of common table salt to the action of an electric current. The use

*The author was not present. His paper was read, in French, and then presented in a brief abstract, in English.

†Chief of Local Supervision, Potable Water Supply of Paris, France.

of the powder is more widely practiced at this time, owing to the fact that it is better understood and because it is somewhat cheaper, but it is to be pointed out that with the improved electrolizers which are now being built, if salt can be obtained for ⅓c. per lb. and electric current 1½c. per kw.-hr., it is probable that the electrically prepared hypochlorite of soda will prove to be as cheap as, if not cheaper than, the hypochlorite of lime in the powder form. With the liquid hypochlorite there is no sludge to be dealt with, and in the case of the hypochlorite of lime a small quantity of sludge, not great to be sure, has to be disposed of at semi-frequent intervals. With the liquid hypochlorite there is no offensive dust, and this is a factor of no small importance. Much is to be looked for in the near future as regards the adoption of the electrically prepared hypochlorite of soda, which is quite as efficient, if not more efficient per unit quantity of available chlorine, as hypochlorite of lime.

If nothing more were needed to prove the real value of hypochlorites in water sterilization, the large number of spectacular epidemics of typhoid fever, which have been stamped out through the introduction of hypochlorite plants in the last few years would be ample evidence. During the past few years such epidemics have been promptly and economically stopped in many cities in this country, among which may be mentioned Des Moines, Iowa, Erie, Penn., Kansas City, Mo., Milwaukee, Wis., Minneapolis, Minn., Montreal, Que., Omaha, Neb., Strathcona, Alta., Toronto, Ont., and Trenton, N. J.

Prof. G. Gaertner, of Jena, Germany, spoke at length in German. Summarized in English, the gist of his remarks was that killing disease germs by storage, as recommended by Dr. Houston, may sometimes require a long period and even then supplementary disinfection may be needed. Ozonization may be very well, but in some cases has been used as an over-refinement. In one instance it was applied to a water containing only 10 and sometimes but 3 bacteria per c.c. He appreciated a joke as much as anyone, but this is carrying a joke too far. The ultra-violet ray is still experimental. The use of chlorine is commendable.

Rudolph Hering, of New York City, said that Prof. Sedgwick failed to mention the largest example in the world of safeguarding an unfiltered water-supply. San Francisco now uses some 40,000,000 gal. a day, from a drainage area largely owned by the Spring Valley Water Co. Much of the land is fenced in, practically no habitations on or access to the drainage area are permitted, and large reservoirs provide long periods of storage. There is no treatment, except straining through cheese cloth, for the removal of dust and odor-producing organisms.

He believed the Germans are right in demanding that all water-supplies be taken from the ground or else filtered. Of course there should be sanitary protection also. He did not think reliance could be placed on storage without filtration, even if there is sanitary protection.

Separately Molded Concrete Guard Rail for Roads

Following the recommendations of certain state highway commissions favoring the use of some type of permanent guard rail for roads instead of the rapidly deteriorating wooden rail, there has been recently put on the market a separately molded concrete guard rail, which is made in a factory and shipped to the proper location and erected there. Fig. 1 herewith shows the details of the rail. It consists of posts 5x7 in. in section by 6 ft. 6 in. long, set in the ground and anchored back into the embankment to concrete blocks by galvanized-steel anchor bolts. On top of the posts are set the rails, which are of hollow construction, as shown in the isometric view in Fig. 1 and in the view of the casting yard in Fig. 2. The rails are hollowed out for lightness and are provided with curved pockets into which the curved tops of the posts fit. Special rail sections are available with mitered ends to be set on any curve required. Reinforcement as shown in Fig. 1 is provided.

There are no metal fastenings other than the anchor bolts and the rail rests on the posts and is held rigid only by its own weight and the fit in the joints. Adjacent rails are not set tight, but a small opening is left for expansion or movement. The rails weigh about 325 lb. apiece and the posts about 225 lb.

This rail was devised by J. Y. McClintock, County Superintendent, Monroe County, N. Y., and is made by the Concrete Guard Rail Co., of Rochester, N. Y.

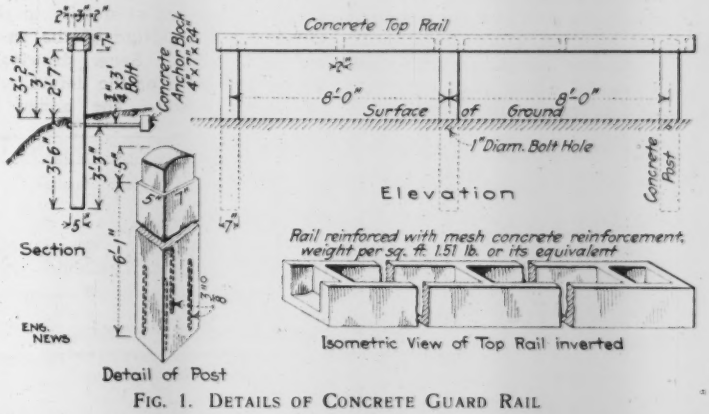

FIG. 1. DETAILS OF CONCRETE GUARD RAIL
(Devised by J. Y. McClintock.)

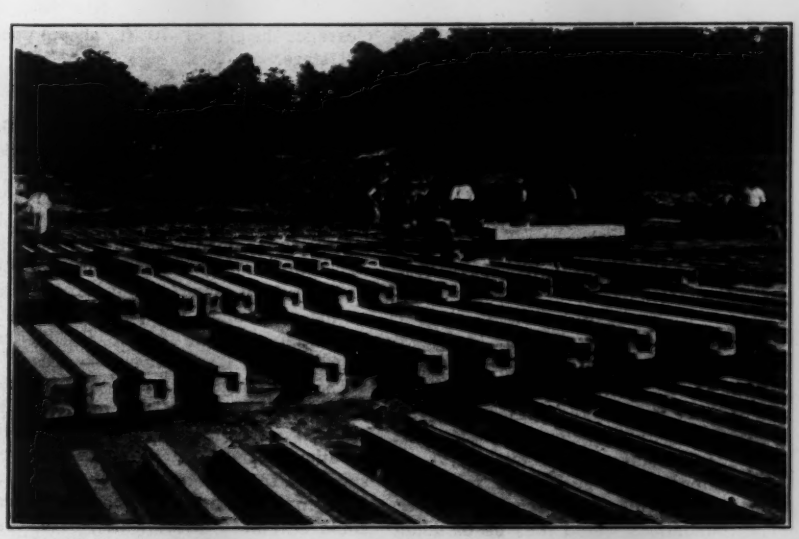

FIG. 2. VIEW IN CASTING YARD, SHOWING RAILS CURING

North Side Point Bridge, Pittsburgh.

The North Side Point Bridge over the Allegheny River at Pittsburgh, Penn., is a modern heavy truss bridge, with very long spans, which replaces a privately-owned bridge at the same location torn down by government order some years ago.

The old privately owned bridge over the Allegheny River at the Point, Pittsburgh, connecting Pittsburgh (old city) with Allegheny (now the North Side) was torn down six years ago as the result of orders of the War Department requiring greater navigation clearance under this bridge. The owners of the bridge took no steps to erect a new structure, and subsequently the city decided to erect a free bridge on a location directly adjoining. The piers for this bridge have been under construction during the last two seasons, and erection of the steel work of the superstructure has just been started.

The substructure of the new bridge consists of concrete piers faced with Beaver sandstone above a point just below low water. These piers were carried to rock by means of a combination of open dredging and pneumatic methods. The depth of water at the site is about 20 ft., and the total depth to rock is only about 40 ft. below river level at "pool full" stage (or about 70 ft. at maximum flood stage). The rock surface is practically level across the river. The foundations would thus be of minor interest, except for the rather unusual method of construction—a combination of open dredging and compressed-air work—and for a peculiar accident which occurred in the course of the sinking of the river pier.

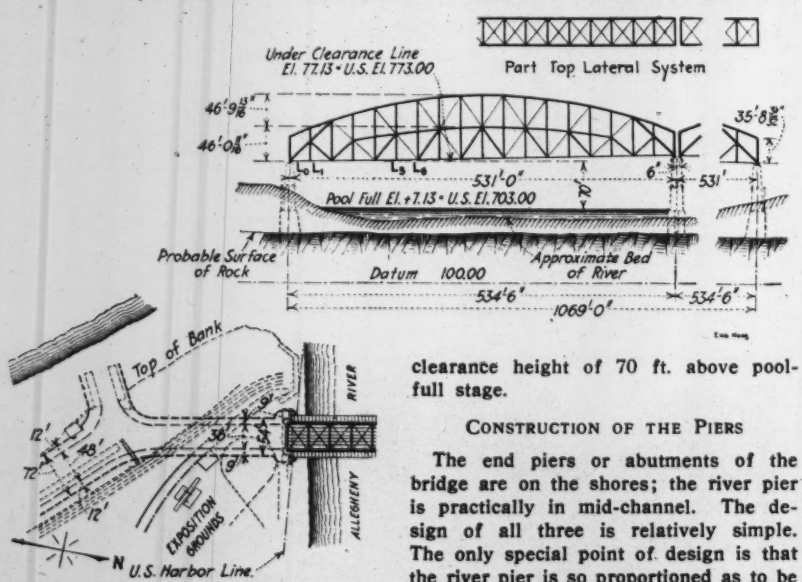

FIG. 1. OUTLINE SKETCH OF NORTH SIDE POINT BRIDGE OVER ALLEGHENY RIVER AT PITTSBURGH

The superstructure of the bridge consists of two truss spans (see Fig. 1), each 531 ft. long, center to center of bearings. The spans are heavy, being designed for a solid floor of buckle-plates, concrete, and block paving. The roadway is 36 ft. wide and along each side is a 12-ft. sidewalk, making a 60-ft. deck. A number of details in the arrangement and design of the steelwork are of interest. Some drawings are shown and some of the details referred to farther below. The bridge has a clearance height of 70 ft. above pool-full stage.

CONSTRUCTION OF THE PIERS

The end piers or abutments of the bridge are on the shores; the river pier is practically in mid-channel. The design of all three is relatively simple. The only special point of design is that the river pier is so proportioned as to be stable under high-water conditions with ice gorged on one side but flowing free on the other side; the pier can resist a horizontal pressure of 48,000 lb. per lin.ft. applied 60 ft. above the base.

The specifications required the pier foundations to be sunk to rock, it being optional with the contractor to use excavation in the open or under air pressure. If sound bottom could be reached by open-air methods the footing concrete could be placed under water. However, a leaner concrete was allowed in case of air deposition. As the work was actually done, all three footings were sealed to rock under air.

The contract for the construction of the piers was let Mar. 23, 1911, to the Dravo Contracting Co., of Pittsburgh. Work was begun on the north shore and river piers Apr. 5, 1911; these were required to be completed Jan. 1, 1912, and the south pier by June 1, 1912, but this program was overthrown by the accident to the river pier.

The same method of working was used for all three piers. The general plan was to sink the piers to a depth of about 20 ft. by dredging through open wells, and then carry them to rock under compressed air by closing the shafts and converting the pier shafts into pneumatic caissons. The open sinking was to go on under protection of a surrounding cofferdam. Description of the center-pier foundation will serve as typical.

The pier cylinder was constructed of concrete, 83½x23 ft. ground plan, with four rectangular wells 10x9 ft. spaced 19 ft. center to center.* Each well expanded at the lower end into a common chamber 7 ft. high, with a 9-ft. tapering portion between chamber and shaft. A steel angle formed the cutting-edge. Vertical reinforcement was placed in the concrete below the top of the working chamber, but above this there were only short dowel rods connecting the successive stages of the concrete. Three-inch vertical pipes were built in the concrete around the outside and between the wells for jetting, but these were never used.

The soil to be sunk through was gravel and sand, not packed, overlain by a thin layer of river mud. The underlying rock was calcareous sandstone on the north side and blue limestone on the south side. Its surface was practically level across the river, but dipped slightly upstream. The pier penetrated regularly and without trouble (in the case of the north pier it was necessary to put on weight even before air was applied, and ultimately during the final sinking to rock and sealing under compressed air a total of 1200 tons weighting was on this pier).

Thorough soundings taken at the sites of the three piers before work began, to show the rock surface, were used as a guide in shaping the cutting-edge to fit the rock surface. The intention was to land the cylinder directly to a uniform bearing on the rock and avoid the necessity of cutting into the rock to bed the entire cutting-edge. It turned out, however, that the divergence of the rock from the surveyed profile was enough to require cutting into the surface to form a level seat.

The site of the center pier was surrounded by a single-wall cofferdam of steel sheeting, banked with earth outside. The cutting-edge was erected on earth filling in this inclosure and the concrete

*The wells in the shore piers were 12 ft. 3 in. square; in the case of the south pier they were changed to round when part way up.

started. Excavation proceeded with use of an orange-peel bucket working through the four wells. The concrete sides of the pier were built up in sections about 8 ft. high as the sinking progressed.

board reported in substance that the pier could readily be made adequate by proper longitudinal bonding and tying; that by this means it could be successfully sunk to rock; and that when sunk to rock and properly filled with concrete it would be in all respects satisfactory and sufficient to carry its load. However, the Department of Public Works of Pittsburgh did not accept this recommendation, but required the cracked pier to be removed and a new one sunk in its place.

fully regulated, and only four buckets were excavated from any one well before proceeding to another; beginning the dredging in one of the end wells, the bucket next worked in the opposite end well and then in the two intermediate

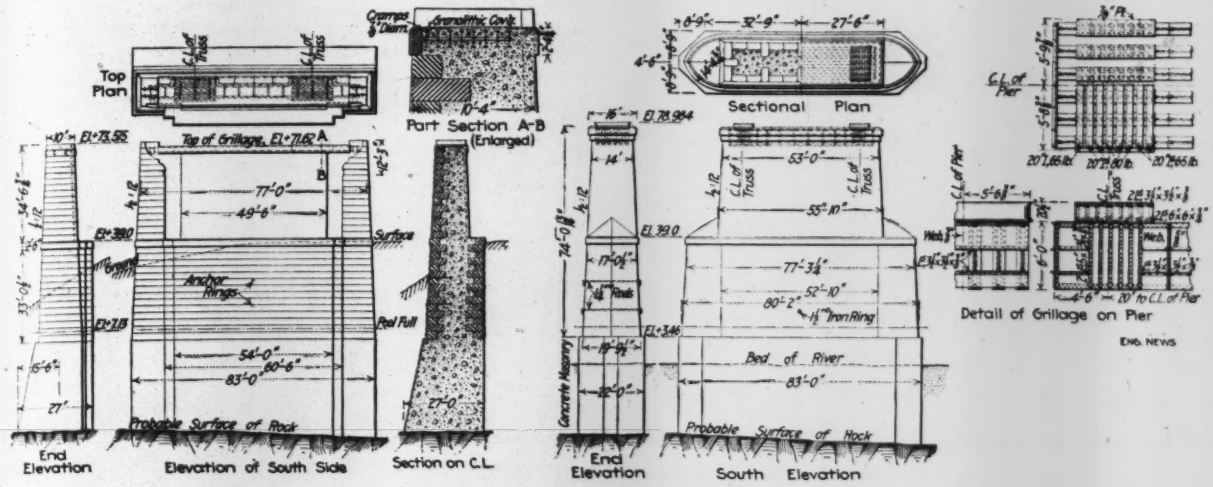

FIG. 2. PIERS OF NORTH SIDE POINT BRIDGE
(Shore piers on left; river pier on right)

When the river pier had been sunk to a total depth of about 17 ft. below river bottom (to cutting-edge), its total height then being 31 ft., it developed a transverse crack about at mid-length, extending from the top to below the river bottom. The crack was about 5 in. wide at the top, narrowing downward. The two views Figs. 5 and 6 show the crack so clearly as to require no further explana-

The pier was blown to pieces by explosives and the site dredged out. The new pier, built in place of the old one, wells, with a view to keeping the dredging as much distributed over the whole length as possible. By this method the pier was successfully sunk nearly to rock. Sealing to rock and setting into the rock were done under compressed air, a deck for the working chamber being built at the top of the chamber below the wells.

Before this point was reached, how-

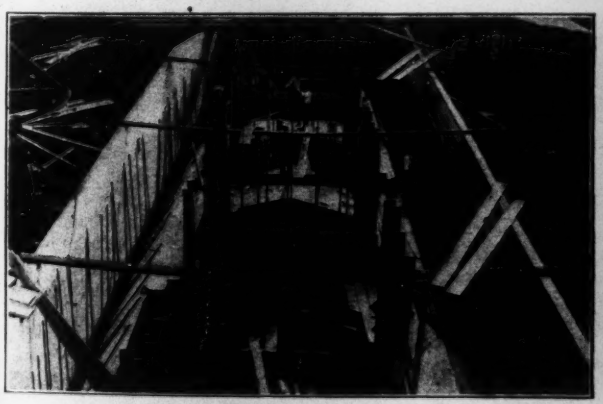

FIG. 3. BOTTOM SECTION OF FORM FOR NORTH PIER FOUNDATION, NORTH SIDE POINT BRIDGE

FIG. 4. SOUTH PIER FOUNDATION OF NORTH SIDE POINT BRIDGE, SHOWING DREDGING WELLS

tion. It was evident that the failure was due to inequalities of dredging through the several wells, causing the load to bear chiefly at midlength of the pier, and producing excessive longitudinal tension in the top of the concrete, which lacked longitudinal reinforcement.

The pier after cracking was investigated at the request of the contractor by a board of competent engineers. This was also designed for open dredging for the major part of the sinking, but the wells were made smaller (round, 6 ft. in diameter). For longitudinal strength each 8-ft. section of the concrete was provided with a belt of longitudinal reinforcing rods near the top of the section. Dredging was done by a derrick boat so placed that it could dredge from any well. The order of dredging was care-

ever, the pier suffered a second accident, which fortunately was not serious. The cutting-edge was but little below river bottom when the ice in the Allegheny River went out. The total height of the pier at this time was about 25 ft. The water overflowed the cofferdam, and the current scoured sufficiently inside the cofferdam to cut out the soil below the upstream edge of the pier and tilt it out

of vertical. When work was resumed the high or downstream side of the pier was very carefully dredged through the wells, and ultimately the structure was restored to true verticality and was then found to be only a very small distance out of line, not enough to affect its full serviceability. After this incident sinking progressed without further interruption.

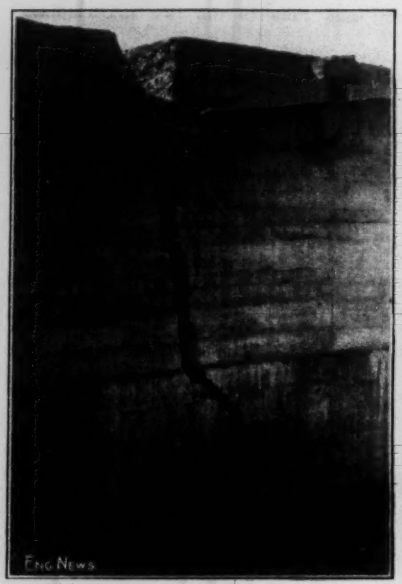

FIG. 5. OUTSIDE OF NORTH WALL CRACKS IN RIVER PIER FOUNDATION, NORTH SIDE POINT BRIDGE
(Views taken July 25, 1911.)

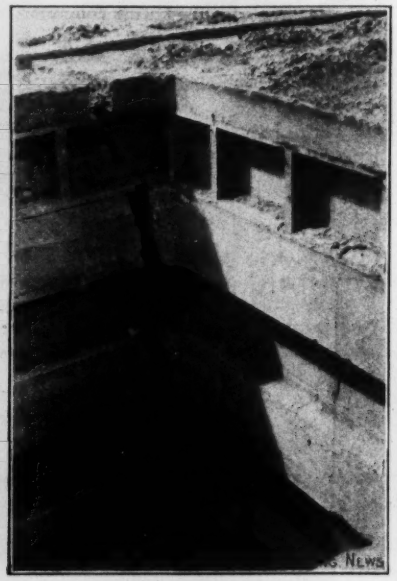

FIG. 6. INSIDE OF SOUTH WALL

The most important effect of the interrupted progress of the center-pier construction upon the bridge as a whole was to delay completion of the structure. The program which had been arranged for erection was to erect the north span first, leaving the southerly channel open for navigation, and in the meantime completing the south pier, for which the contract provided six months longer time than for the north and river piers. When the north span was erected the falsework was to be removed from this span and transferred to the south span, and this latter erected. What actually happened, however, was that the two shore piers were completed at an early stage, but the river pier not only was uncompleted at the time originally set but even exhausted the period specified for final completion of the third pier. As a result, the first work toward erection of the steel superstructure, driving falsework piles, could not be begun until approximately Aug. 1, 1912. An effort will be made to erect both spans this season, but it is possible that the southerly span will have to wait until the ice goes out in the spring of 1913.

The sketch drawings of the piers, Fig. 2, show the construction of the pier tops to tie the masonry and distribute the bridge load. In the case of the shore piers, there are seven 18-in. I-beams longitudinally under each shoe, and two of them extend the full length of the pier for longitudinal tying. The center pier is different because it is shorter and because both spans have their expansion on this pier. The distributing beams are placed transverse to the pier (longitudinal to the bridge), and they are in turn carried by a group of six 72-in. plate-girders set longitudinal to the pier, these not only tying the pier masonry but also distributing the bridge load over the whole length of the pier. It will be seen from Fig. 2 that the river pier is 22 ft. shorter than the shore piers, the latter being made long to carry the entrance-arch masonry. The need for longitudinal tying and load distribution is therefore greater in the case of the river pier.

BRIDGE SUPERSTRUCTURE

The truss outline and the arrangement of the bracing are shown in a general way in the outline sketch Fig. 1. This supplemented by the cross-sections in Fig. 8 and the detail sketch Fig. 9 will give a satisfactory idea of the nature of the steelwork. It is to be remarked that, although the bridge has a buckle-plate floor over its whole length, bottom laterals are used in addition, these being placed in the plane of the bottom flange of the stringers and riveted to the stringer flanges at the intersections.

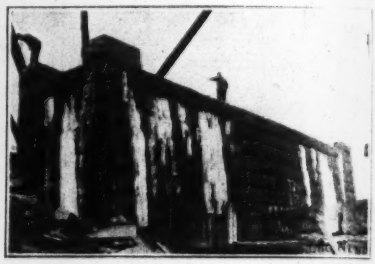

FIG. 7. UPPER PART OF NORTH SHORE PIER OF NORTH SIDE POINT BRIDGE
(Feb. 26, 1912.)

The wind bracing has the further peculiarity that the portal bracing which takes the end reaction of the top lateral system is not located in the plane of the inclined end-posts, but in a vertical plane over the end shoes. The construction here is fairly well shown by Fig. 9. False end-posts were required in any case, as it is

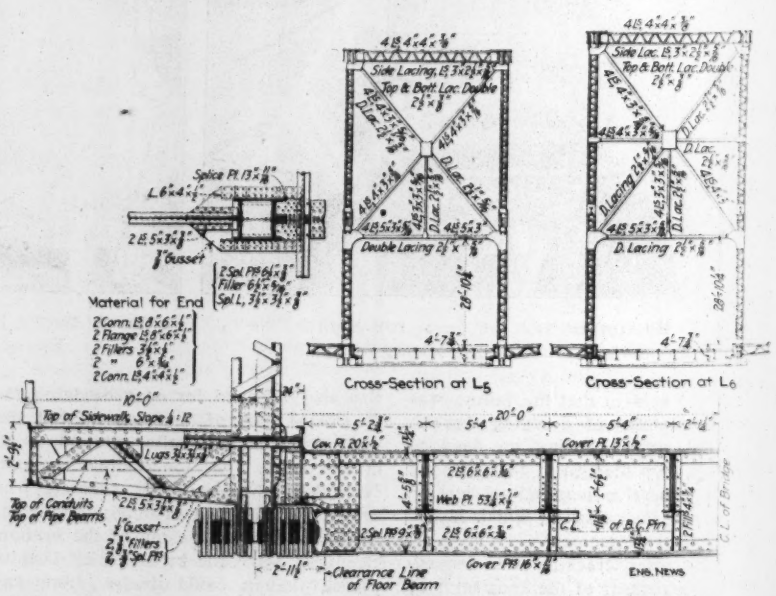

FIG. 8. CROSS-SECTIONS OF NORTH SIDE POINT BRIDGE

the intention of the city authorities to construct ornate stone portals over the piers at either end of the bridge. The portal posts will be inclosed in this stonework, as will also the plate-girder portals.

The bridge is of pure pin-connected type. The maximum pin size is 12½ in. The connection of the floor-beams to the posts is made clear by the section Fig. 8. The floor-beam is notched around the pin keeping the approach grades as flat as possible. The total depth from under-clearance to top of curb is 5 ft. 9 in.

The roadway is paved with stone block in the end panel at either end of the bridge, and with wood block over the remainder of both spans.

The buckle-plates are laid with buckles up, except for the strip along either curb, which is laid buckles down. In this strip a drain hole is drilled through the low top of the roller chamber. The 12-in. segmental rollers are completely inclosed in a tight cast-iron box filled with oil.

The joint in the roadway over the river pier, where expansion will occur, is covered by a grooved steel plate, also shown in Fig. 10. This laps over the wood-block paving of one span. The built steel curbs across the end of the roadway of either span, which carry this expansion plate, are supported by brackets

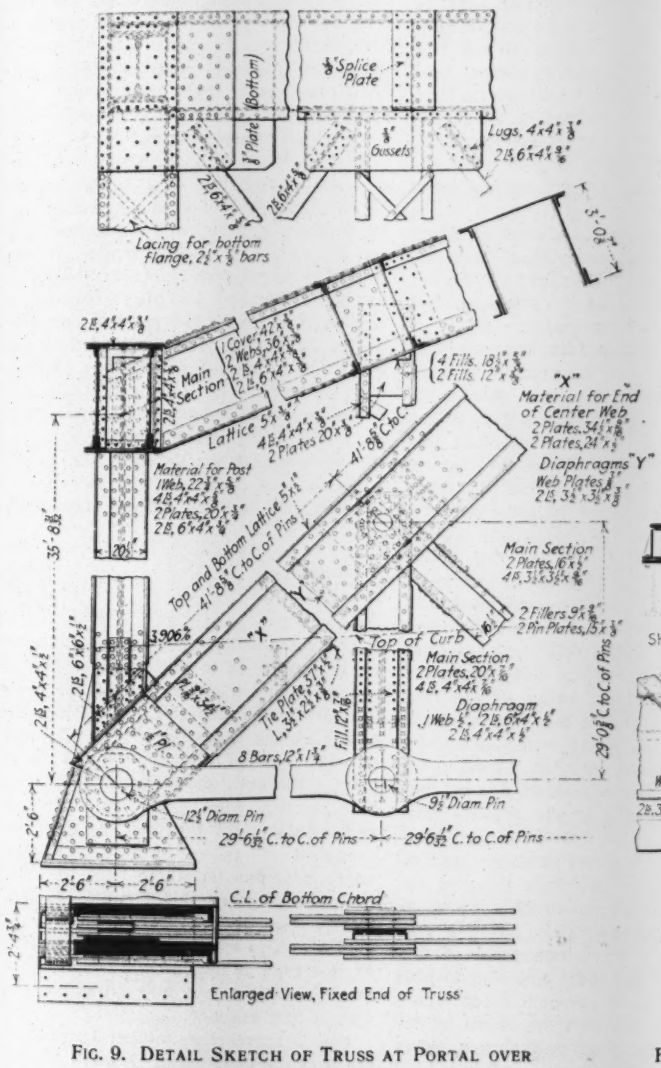

FIG. 9. DETAIL SKETCH OF TRUSS AT PORTAL OVER RIVER PIER, NORTH SIDE POINT BRIDGE

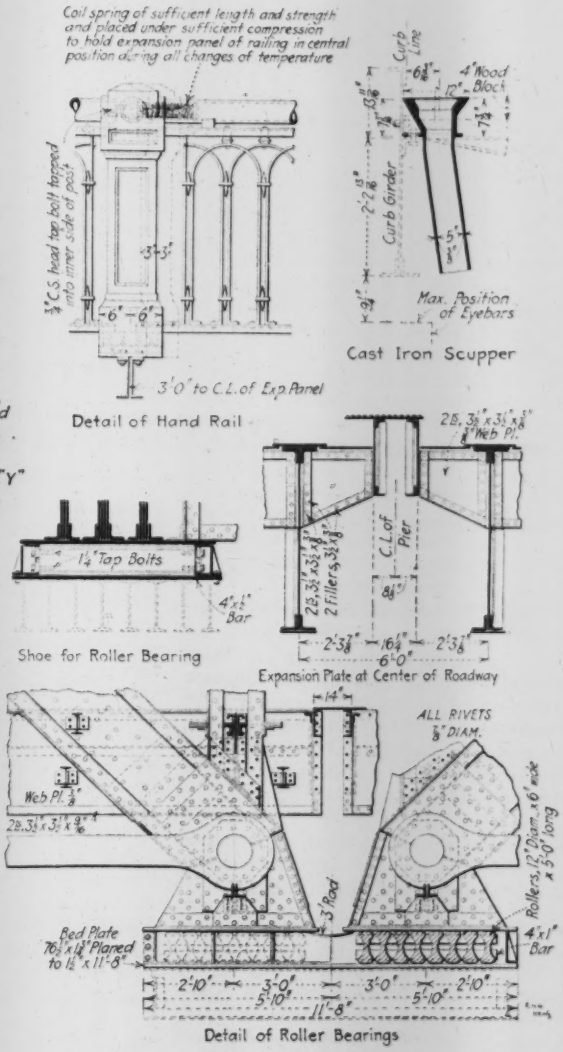
Coil spring of sufficient length and strength and placed under sufficient compression to hold expansion panel of railing in central position during all changes of temperature
Detail of Hand Rail
Cast Iron Scupper
Curb Line
Curb Girder
Max. Position of Eyebars
3'0" to C.L. of Exp. Panel
Shoe for Roller Bearing
Expansion Plate at Center of Roadway
C.L. of Pier
Bed Plate
Rollers
Detail of Roller Bearings

FIG. 10. DETAILS OF EXPANSION, ROADWAY AND RAILING, NORTH SIDE POINT BRIDGE

and suitably reinforced to bring up the shear value of the reduced section.

The main compression members of the bridge are designed with three webs tied at the ends by transverse diaphragms. This applies to the upper chord and the end posts. The open sides of compression members are fitted with two-rivet single lattice.

The floor is rather shallow for a bridge of this size, on account of the need for point of each buckle. To decrease the depth of floor, the buckle-plates are kept below the level of the top flanges of the floor-beams, and extend below the floor-beam cover-plates.

The fact that both spans have their expansion on the river pier has already been noted. One of the details in Fig. 10 shows the arrangement used here. A curved plate connects the adjoining upper edges of the two shoes, closing off the attached to the web of the end floor-beam. The plate is 1 in. thick and is grooved ¼ in. wide and ⅜ in. deep.

It was thought necessary to provide expansion in the railing also, and as the total length of expansion is about 6 in. per span (for 150° F. temperature range) a method of caring for this expansion was desired which would not open any wide spaces at minimum temperature. The railing immediately over the river

pier, therefore, is formed into a 6-ft. section which is an expansion length, and both ends of this section is spring-connected to the railing post, as shown by the detail in Fig. 10. By this means the railing is always firmly supported and held central. The spring acts in compression in both directions.

The height of the railing is 4 ft. This height is found to be safer and more satisfactory than lower railing heights, as exist on some of the Pittsburgh bridges.

Approaches

The plans for the approaches are being drawn to harmonize with the plans of the flood commission for construction of a flood-protection river-wall on the Pittsburgh (south) bank, and to meet the views of the Art Commission, which desires a suitable development of the common approach to the two Point bridges (Monongahela River bridge and the one here described, or Allegheny River bridge) and a monumental treatment of the small irregular piece of land between, which forms the Point. It is probable that a series of concrete arches and an embankment approach of at least 5% grade will be built, with entrances from Water St., Liberty Ave. and Duquesne Way, passing by the freight yard of the Pennsylvania R.R. with retaining-wall along this yard. Terraced parking with monumental decoration has been designed for the Point, lying between the entrances to the two bridges.

The north approach involves less complication in the way of requirements for monumental treatment and connection to streets, etc. An approach of concrete arches and terminal embankment will be developed here also. As already noted, the portal at either end of the river spans will be developed by a stone archway or entrance inclosing the steel portals.

The total cost of the approaches will be about $300,000, a third of which is chargeable to the decorative and monumental development.

General

The cost of the substructure of the bridge (three main piers only) is $196,512.80. The two steel spans, erected, will cost $300,000, exclusive of the paving, which is to be put down as a separate contract.

The bridge was designed in the office of the Division Engineer of Bridges of the Bureau of Construction, Department of Public Works, Pittsburgh. Jos. G. Armstrong is Director of the Department of Public Works, N. S. Sprague is Superintendent of the Bureau of Construction, and T. J. Wilkerson is Division Engineer of Bridges. The Dravo Contracting Co. built the substructure, and the American Bridge Co. is fabricating and erecting the superstructure. The contracts for the paving and for the approaches will probably be let this winter. Completion of the approaches will delay the opening of the bridge to traffic probably to Jan. 1, 1914.

Types of Defective Rails and Some Methods Used in Detecting Them*

By Robert Job†

(With full-page plate)

Under present conditions of railroad traffic in this country it is of especial importance to secure strong, sound and durable rails. The compositions best adapted to the varying requirements have been fairly well determined by the teachings of service. The openhearth process, which permits the use of greater toughness and hardness through low-phosphorus and sulphur content, has been widely extended, and the various principles and details of manufacture have been so thoroughly studied that our mills are capable not merely of large tonnage but of high excellence in quality.

It is a well known fact, however, that decided variations in the product at times occur. Sometimes the large maority of the rails from a given rolling give generally good service, while only a small percentage are found to contain defects which cause failure in track. In other rollings from the same mills the percentage of defective rails is much higher, although the rails may be used under nearly identical conditions as to track and service. In many instances good rails immediately beside one which failed have been removed from track and carefully studied with the object not merely of finding out the exact cause of the failure, but also to ascertain the qualities which under the same traffic conditions resulted in good service. This work naturally has been extensive, and its consideration in detail at the present time would weary your patience. It may, however, be of interest to show types of various failures which in a measure are characteristic, and which have come to our attention under widely differing service conditions in various parts of this country and of Canada, and also to give a brief account of some methods which have been devised with the object of detecting defects which would detract either from safety or from serviceability.

One of the best known popularly of these defective types is the so called "piped rail" (Fig. 1) caused by defective mill practice in failing to crop the blooms back to sound steel. A rail of this kind does not generally fracture in track, but mashes down gradually and is detected by the track men and removed before it becomes unsafe.

Another type (Fig. 2) is the split head, and in the present illustration the flowing over upon both sides of the head is shown. This section has been polished and lightly etched with iodine and it will be seen that the metal is thoroughly unsound—again due to failure at the mill to crop the blooms to sound metal. As a result, the steel has too little tenacity to support an ordinary load, and crushes. A somewhat similar condition is shown in Fig. 3—a new 80-lb. rail which had not been in track. This rail would probably have developed the same defects, slivering at the sides and splitting through the head even under light traffic, especially so since the carbon content was only 0.43%, with phosphorus at 0.109%.

In Fig. 4 we look down upon the top of a 100-lb. rail from which a layer about ⅜ in. thick has broken out in service. A seam runs lengthwise through the rail, and by carefully observing the fracture it will be noted that the failure began at the seam line and extended gradually in service until the crack reached one side of the head and nearly extended to the other. A failure of this kind is particularly dangerous since it is gradually developing while the rail is in service and no outward indication may be given of the presence of the defect. The rail in question was made by the openhearth process and had the following composition:

Manganese	0.82%
Sulphur	0.030
Phosphorus	0.025
Carbon	0.77

The composition was normal and gave no indication as to the cause of failure.

Fig. 5 shows an etched section from the same rail taken at the same location, and it will be seen that the steel is thoroughly unsound and porous and shows clearly the spot at the seam line. Another section, Fig. 6, was cut at another part of the same rail and has the same condition of radical unsoundness. An analysis of powder which lined the seam showed that it consisted mainly of slag, though also about 1.5% of carbon was present. The exact method of formation of this type is beyond the scope of our present subject, but it is an evident defect in mill practice.

Fig. 7 represents another longitudinal crack of the same type. In each of these cases the composition was normal, but the same condition of extreme unsoundness, resulting from defective mill practice, was present.

Fig. 8 gives another example of a radically unsound rail with a split lengthwise in two planes; Fig. 9 shows the upper portion of the head with the slag-line at which the fracture began. Fig. 10 is a similar type, with a longitudinal seam through the head; the defective character of the steel is clearly shown in Fig. 11.

*A paper presented before the International Society for Testing Materials, New York City, Sept. 5, 1912.

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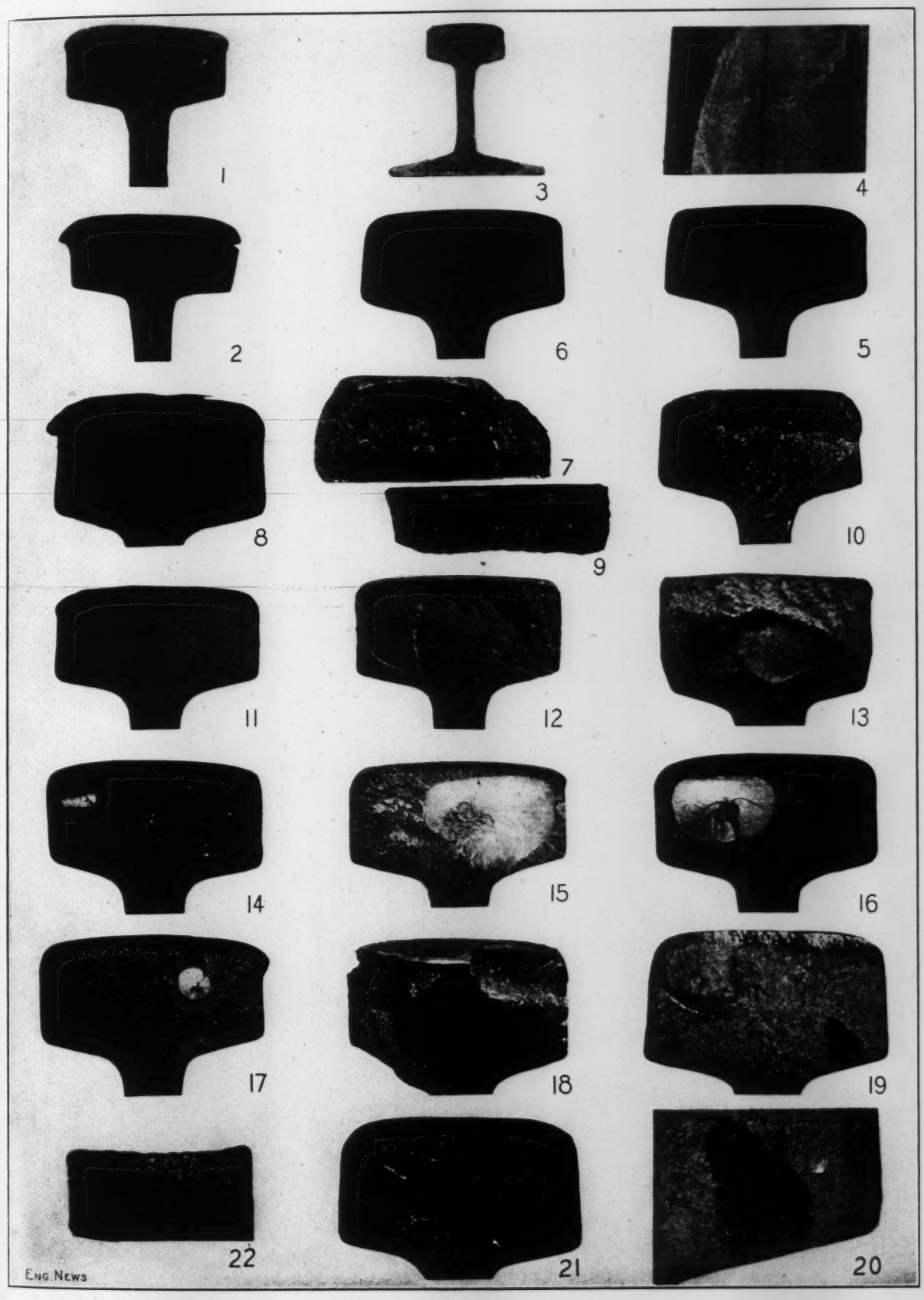

Typical Defects of Steel Rails

(With paper by Robert Job, "Types of Defective Rails and Some Methods Used in Detecting Them;" Presented before The International Association for Testing Materials, at New York City, September 5, 1912)

This condition obviously would have been avoided by proper mill practice.

Fig. 12 shows the type of failure known as an "internal transverse crack." This is also particularly dangerous since it is not present in the rail when rolled but begins to develop in service at some point of weakness within the steel, and gradually extends across the head until fracture of the rail occurs. The rail in this case was made by the bessemer process and had the following composition:

Carbon	0.67%
Phosphorus	0.058
Manganese	0.88
Sulphur	0.041

This rail was removed from track and broken under the drop test, but a similar crack, though smaller, is shown in Fig. 13, about 3 ft. from the first, in the lower part of the head near the web, while about a foot further along the rail a small crack, in embryo so to speak, was found (Fig. 14). Another failure of this type is shown in Fig. 15, which represents an openhearth rail of the following composition as compared with its heat analysis:

	Rail Analysis	Heat Analysis
Carbon	0.86%	0.65%
Manganese	0.74	0.81
Phosphorus	0.030	0.024
Sulphur	0.050	0.055

The rail was thus decidedly segregated, indicating defective mill practice.

A characteristic form is shown in Fig. 16 and the nucleus of weakness at which the fracture began is clearly seen near the center of the crack. Fig. 17 illustrates again the gradual growth of what later on would have been a failure of this nature; the spot of weakness at the center is evident.

Owing to the dangerous character of this type of failure and the need of definite knowledge as to the prime cause of the growth, we made a critical study of the subject, gathering data throughout the country. I shall not burden you with details; it will suffice to say that the defect was found in low-carbon and in high-carbon steel; in rails as heavy as 100 lb. per yd., and as light as 80 lb. In some cases, where rails as light as 67 lb. were used and subjected to the same wheel pressures, none of the defects had developed.

As has been mentioned above, the defect was found, in relatively small numbers, in both bessemer and in openhearth steel, made at different mills scattered over the country and in service in various parts of this continent. Thorough study proved beyond question that the composition of the steel in its ordinary elements was not the cause of the failure, and also that the conditions of service were not the prime cause. Analysis of the small central core in these "spots" was not conclusive. Microscopic investigation proved that the "spots" were mere cracks and did not extend longitudinally along the rail; in other words, they had no depth. But, on examination of the steel in the immediate vicinity of the central core, we always found decided porosity or other source of weakness, this condition being caused by various defects in the mill practice.

In one of these unsound rails (Fig. 18) two internal transverse cracks had developed within about 1 in. of each other.

Another characteristic form of internal transverse crack is seen in Fig. 19, a badly segregated openhearth rail in which the manganese content was 1.62%, although the heat average approximated 0.80%.

Fig. 20 shows a three-fold enlargement of the spot just shown, and by noting the formation of the ridges it will be apparent that the fracture began inside the head and gradually extended until it reached the surface. The spot was about ¼ in. long. Fig. 21 represents a similar crack in a 110-lb. openhearth rail in which the manganese was also excessive, 2.65% being present, whereas the heat average was approximately 0.90%. In both of the latter cases the abnormal composition was caused by failure in manufacture properly to mix the manganese added in the ladle.

The types of various defects might be extended almost indefinitely, but I will limit myself to one other, Fig. 22, which has been found to cause difficulty resulting in the so called "moon-shaped fracture." This represents the base of a rail in its natural size with a seam line extending along the rail nearly at the center of the bottom of the base. Rails which contained this defect of manufacture were usually seamy throughout the sections as will be seen in the example.

Our experience has been that defective condition is very seldom characteristic of an entire rolling, but that it is generally present only in individual ingots. Consequently it was clear that in order to guard most effectively against the various defects and at the same time utilize the largest possible proportion of the rolling, it was desirable to test each ingot in the rolling, stamping each rail with its ingot number, in addition to the heat number and the letter indicating its position in the ingot. Also, in order to forestall as far as possible the various defects in the rails, we found it advantageous to place a considerable number of inspectors throughout the mills in order to watch the progress of the manufacture in its various details and to report all variations which would tend to lessen the value of the product. The plan has been in operation for about one year with very satisfactory results.

These extraordinary, though now needful, precautions on the part of a railway company should be unnecessary since they are intimately connected with the manufacture of the steel and should properly be observed by the mill itself to safeguard the quality of its own product.

Of the routine tests, we have found it advisable to make a drop test upon a butt from each ingot in the heat in order to avoid brittleness, rejecting all rails from each ingot which fail under the test. The ductility test of P. H. Dudley has also been found extremely useful in helping to avoid qualities which result in some of the types of failures shown above. The test to destruction, under the drop, to detect piping is also of great value, and serves as a check upon the work of the men at the shears and tends to reduce to a minimum the number of piped rails in any given shipment, particularly when the tests are made upon the ingot plan mentioned above. The deflection measurement under the drop test enables one to avoid undue softness, while base seams may be detected if present by making the drop test with the head of the rail downward, as is our regular practice, but with the base slightly inclined so that the drop will strike the extreme side of the base and thus open up as a result of the blow any unwelded seams which may be present. If seams are found, the top rail of the ingot might properly be rejected. This modification does not interfere with the effectiveness of the drop test in other respects.

In brief space, I have tried to outline some important causes of failure of rails under present conditions of service, and to mention briefly various methods which have been devised and developed from time to time in the effort to detect unsafe or unserviceable material in the product offered by the mills. An immense amount of work has been done in this connection and has been necessary in view of the conditions which have been encountered. I wish, however, to emphasize with all the force of which I am capable, the absolute unfairness of forcing upon the railroads of this country the detecting of defects which, if the rails were properly made, would seldom be present in the steel. I believe also that I am not amiss in stating that it is today the earnest wish of every one who has at heart the interests of our railroads, the safety and economy of traffic, and the integrity and development of our manufactures, that the day may not be distant when every artisan in our mills, from the highest to the lowest, through the compensation received in return for his work, shall be made to realize that quantity of production is not the main goal toward which his energies should be directed, but that quality is the prime requisite. My faith in the efficiency and capacity of our mills is so great as to convince me that, under such a system, the mills would become noted in greater measure than ever before, both for extent of production and excellence of the product.

The Relation of the Contractor to the Public Official*

By C. A. Crane†

A discussion of the relation between contractors and public officials might be divided under three heads: What they are thought to be, what they are and what they ought to be.

What they are thought to be finds its only parallel in the nursery belief in Santa Claus, which is no more hallowed than the time-honored tradition in every newspaper office in the country concerning the financial status of contractors. There is never an event chronicled in the press in which a contractor figures, that he is not mentioned as "so and so, the wealthy contractor." All of which prompts the unnecessary question, "Where did he get it?"—unnecessary because the general public harbors the delusion that the wealth was attained in public contracts in collusion with public officials.

There is perhaps no industry which is so intimately connected with the progress and welfare of a country as that of the contractor. His task is the physical development of the locality. The work is in the open and its progress is carefully watched by the community. Every passer-by is a self-appointed inspector; his criticisms are governed more by personal inconvenience than by any real knowledge of how or why the work is being conducted, and proportionate with the inconvenience, is the firmness of his conviction that the contractor and the public officials are leagued together in a "public be damned" policy. In any event it is the popular belief that the contractor is amassing a fortune and only gets his contract through "pull."

In all candor we are bound to admit that there has been great justification for this belief. Doubtless we are all familiar with the practice, sometimes observed in the smaller towns, of receiving the bids in public, but opening them in executive session. To insinuate on the reasons for such a custom is inadequate—experienced contractors *know*. These irregularities are deplored by honest contractors—in fact they are deplored by every contractor except that particular one who gets the contract—and the very first time *he* finds the trick has worked in favor of another, he shouts the loudest of all.

Just as dishonest officials are in the minority so are honest contractors in the majority, and they are equally anxious with honest officials and the public generally that the contracting business shall be put on a legitimate basis, which will afford every opportunity for honest competition and minimize favoritism and graft.

A recent editorial in one of our large dailies, commenting on the expenditure of public funds for a large improvement contained this sentence: "In dealing with contractors eternal vigilance is essential." The implication there is that the contractor is the culprit—but dishonesty can't thrive single-handed.

Now we take it that one of the purposes of this Congress is to correct contract abuses and to establish legitimate practice. You must do that before you can succeed in building good roads or anything else, no matter how theoretically perfect a set of specifications you may devise. Since we must all confess that the relations between contractors and officials are not always above suspicion, the problem is to remove the opportunity for suspicion. Why not adopt the policy of the hotelkeeper who announced on his bill-of-fare that "to prevent fruit being taken from the table, there will be no fruit." Cut out all personal relations between contractors and political officials and let these relations be through the proxy of the engineering official. Choose a big man in his profession and pay him a big salary—put him under a heavy bond to guarantee the accuracy of his work and the validity of his certificates of payment. Why should a disbursing officer be held responsible for an engineer's voucher, unless he has equal facilities for checking the work that the engineer had in computing the amount? Centralize the power and the responsibility.

Contractors prefer contracts with railroads and private corporations to public work, because their dealings are almost entirely confined to the engineer or the architect, and they are not encumbered with the delays and red tape that characterize our contracts for public work. To one lawsuit over a railroad contract, there are a hundred over public contracts—and is this not because the railroads employ a higher grade of men to superintend their construction? Men who are competent to and do settle disputes fairly, unhampered by the statutes and ordinances under which public work is conducted. It is true there are many of our large public improvements today going forward under the guidance of the best engineering talent in the country. To these exceptions our criticism does not apply—but to the general custom which places inefficient men in charge of engineering construction on public work.

A serious mistake made by public officials is to underestimate the necessity for paying high salaries to engineers. Well paid positions will attract a higher grade of men and remove temptations which beset the path of the under-paid engineer in the field. The men in the field are relied upon by both the chief engineer and the contractor, and the greatest risk the contractor assumes lies in the ability of this sub-engineer to whom is delegated the power of interpreting the contract.

The success of a contract lies in its execution—not in its wealth of legal protection for the contractee. Take any contract issued today for public work to a lawyer and ask his opinion of it. He will tell you a man is a fool to sign such a document. It is so drawn as to provide every safeguard for the contractee, and to place entire responsibility for everything that may happen, including the acts of Providence, up to the contractor. He literally signs away all his rights in the present and hopes for the future. This is not the work of the engineer, but of the legal officials.

But the contractor wants the work, and in the contracting business three qualities are essential—faith, hope and nerve, and the greatest of these is nerve: nerve to disregard counsel's warning, faith in his own ability to do the work, and hope that the engineer in direct charge of his work will give him a square deal.

It is impossible to over emphasize the importance of the relation of this engineer who is in direct charge. He is called upon to give immediate decisions on important questions, in the absence of his superiors. He is clothed with all the powers conferred in the contract and these are liable to be over-, rather than under-exercised by the too zealous and inexperienced engineer. Care in the selection of his deputies, and personal attention to their training by a chief engineer are tremendous factors in securing harmonious relations with the contractors. Constant bickering prevents good work, and the chief engineers who have been most successful are those who have infused in their subordinates the realization that tact and diplomacy win more battles than obstinacy.

Most contracts designate the chief engineer as the arbiter of all disputes over the amount and fitness of the work, his decision to be final and binding on the contractor, but this power is usually qualified elsewhere in the contract by providing that the engineer's decision shall be subject to the final determination of the Commissioner or the Board, as the case may be.

This qualifying clause might easily become a mischief breeder. Any loopholes which permit the slightest chance for questionable dealings between contractors and officials should be guarded against. The days of the contractor with a "pull" are passing. Even the simplest class of public improvements is now supervised by an engineer. The less that contractors and Commissioners come in contact the better. The Commissioners' attention should be devoted to the administrative details—with matters pertaining to construction left to the engineers. The engineering profession fortunately ranks high in integrity, and the unfortunate cases in

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†Secretary, the General Contractors' Association.

which scandal has entered into the contracts are but rarely charged to any dishonest acts by or collusion with, the engineer. The objection raised to allowing the engineer to be the final judge as to the quantity and fitness of the work, is that since he is paid by one of the parties to the contract he is naturally biased toward his employer, but it is generally conceded that in the majority of cases the engineer who has designed and supervised the work is best fitted to make the decisions. There are many questions, however, which arise that are not concerned solely with quantity or quality—questions of judgment or questions of proper interpretation, and we believe disputes of such nature should be submitted to arbitration. No honest and capable engineer fears or can object to any scrutiny of his work by an equally competent fellow engineer, and, therefore, an appeal from his decision should be allowed before a referee competent to pass upon the technical matters involved. This is the only form of appeal which should be permitted in the contract. An appeal to the Board or to a Commissioner can be made only for the purpose of securing through friendship or worse what the engineer will not allow, and if the Board of Commissioners is honest and has confidence in its engineer, it naturally will deny the request. The position of the engineer who would be asked by his board to alter his determination would be exceedingly unpleasant. He would be in the dilemma of refusing to obey orders or of certifying to something against his judgment. Engineers are human and jobs are not always plenty, and we realize that engineers have their troubles as well as contractors. To avoid such dilemmas, the engineering profession should demand a form of contract providing that their rulings could only be reversed by arbitration before a member or board of their profession.

We realize that there are many questions of law involved in contracts that are often the subject of division by members of the bench, but we submit that if the preparation of the entire contract, as well as the specifications were left to the engineer, he would at least be able to prepare as comprehensive a document as the lawyers, and there could hardly be any question involved which another engineer could not understand for the purpose of making a fair decision. A suit at law is not the most satisfactory way to settle a dispute which really hinges on the question—was the work done as it was intended and represented in the contract? Lawyers naturally look for legal points of attack and defense, and many a case has been decided on a purely legal technicality far beside the equity of the suit.

This arbitration question has been tried out in many forms and unfortunately no method has yet been adopted that seems satisfactory. The Rapid Transit Commission in New York City some years ago provided that an appeal from the chief engineer's decision should be submitted to a board consisting of one arbitrator chosen by the Commission and one by the contractor, and on the failure of these two to agree, a third was to be appointed. It is obvious that the decision thus really lay with the third man, and it would seem a short-cut to name the third man first. Onward Bates, in a very able paper before your Congress at Richmond last fall, pointed out this very difficulty, and after several years' trial by the old Rapid Transit Commission and the present Public Service Commission, the scheme of arbitration has been dropped since it proved quite as costly and consumed as much time, if not more, than the regular court procedure.

It would seem that the single arbitration is the solution of the difficulty, and this scheme is concurred in by the National Federation of Building Trades Employers of Great Britain which recently prevailed upon the Council of the Institution of Municipal and County Engineers to adopt a modification of the clause regarding the engineer as the sole arbiter of disputes. The Council recommended the adoption of a clause submitting the dispute to a single arbitrator to be appointed by the President of the Institution, the award of such arbitrator to be final and binding upon the parties. The nature of the questions to be submitted for arbitration is to be confined to the interpretation of the contract or any matter arising thereunder—but not on decisions as to the quantity and fitness of the work—and also as to the withholding by the engineer of any certificates to which the contractor might claim to be entitled. The arbitration is not to apply to any contract amounting to less than $5000 and no question involving a sum less than $250 shall be submitted. We believe that some such measure might well be considered by our public officials. It would minimize litigation and thus remove one of the greatest sources of friction between contractors and public officials.

The attempt to regulate these relations and to prescribe by statute for nearly every contingency that may arise in a contract is in our judgment a mistake. Laws are no stronger than the men who enforce them, and if it be the fact that laws are necessary to curb our public officials, something is radically wrong with our system of government. You can't legislate honesty into a man—you may render him more cautious, but if he be dishonest he will circumvent any law made. What we need is better men, not more laws, and public office should offer the best men suitable compensation for their services to the public.

This subject is one that cannot adequately be discussed in a short space of time. So much depends on the relations of the contractor and the public official—the success of the smallest undertaking. Reduce them to a minimum—cut out all relations with the *political* official—divorce contracts from politics—and the millennium will be at hand.

Roman Concrete—That there was some standard specification used by the Roman Army I hold to be true, because in every part of the world, wherever you go, you will find the Roman methods are remarkably uniform. The secret of the Roman concrete is a thing which to me is absolutely mysterious. I am very familiar with the great Roman fortress, a mile and a half from Sandwich, Eng., known as Richborough Castle. This enclosure, covering several acres, is still surrounded by a great Roman wall, one of the best preserved outside of Italy, and it was in this fortress that the Romans packed up on their departure from this country. The walls there are about 30 ft. high and 10 ft. thick, and of great length, but when the railways were being constructed the barbarians destroyed that which faced toward the sea in order to use the material for the purpose of the railway. They began to destroy the return wall to this sea front by excavating a great cavity at the base of the wall. It is more than high enough to walk into and it extends 8 ft. 6 in. in depth, and so leaves only 18 in. of walling beyond. The span of that opening is about 50 ft., therefore you have a concrete girder, say, 20 ft. in depth and 50-ft. span and 8 ft. 6 in. in thickness without the slightest sign of a crack. It has stood since the time, say, fifty or sixty years ago, when the cutting was made. In itself that it sufficiently wonderful, but suppose you go inside the wall and consider what it is constructed of. So far as one can see it is constructed of nothing but the materials on the spot. There you see the gravel from the beach, flints from the chalk, and the rough class of half stone, any kind of inferior Kentish rag, which could be obtained near the spot, while the mortar binding these miscellaneous aggregates together appears to be made with the ordinary chalk or stone lime.

What we want to know, therefore, is what did the Romans mix with that mortar which transformed it into a material as hard as our portland cement? Because inside this enormous wall, 10 ft. thick, the setting and consequent hardness of the concrete is just as good as it is on the outside. That is contrary to experience with ordinary lime mortars.

When the Romans left this country something or other which had been mixed in concrete and mortar or some method of preparation was no longer used, and the Normans attempting to do buildings of the Roman character made a fearful mess of it. Most of their central towers collapsed, owing to the mortar being bad, as it became like sand, and the piers collapsed in consequence. Whether the Romans carried about with their armies puzzolana, or volcanic ash, or something equivalent to that in its effects, I do not know, but it is a subject I think exceedingly worth investigation by chemists and societies. To raise the level of the lime mortars, concretes and plasters in common use would confer a great benefit on the building trade of this country, particularly in the country districts.—A. T. Bolton, before the Concrete Institute, London.

Camp Sanitation

By R. C. Hardman*

In the establishment of camps for construction or other purposes too much care cannot be given to the sanitary arrangements for the protection of the health of the men. All too many camps are simply collections of tents or shacks in which no attention is paid to the ultimate end of all camp garbage and refuse. The excuse, of course, is that it is merely a temporary camp; that the added cost of the sanitary precautions comes out of the profits and that it is too much trouble. However that may be, it is highly probable that the cost of this work might be more than taken care of by the longer period which men can be kept and the decreased expense of securing and breaking in men. It will be argued that the average "wop," as the contractors' laborer is becoming to be known, will stay but a short time anyway, and it makes no difference whether a hovel or a palace is furnished for his housing. But it is at least open to discussion whether he will not stay for a longer time and do more and better work if sanitary measures are taken for the abatement of the fly nuisance and the elimination of the odors which all too often characterize construction camp.

To the average camp boss the idea of a flyless camp will come as a joke and provoke an amused smile. And yet by providing proper incinerators and latrines and caring for stable refuse, the "flyless" camp comes very near realization, and that at a very small expense. To be sure, it will be an innovation in most camps, and an innovation that will come hard.

In order to secure good results the site should be a high, well drained piece of ground. This is often impossible. If well drained ground cannot be had all stagnant water should be covered with crude oil to prevent the breeding of mosquitoes. In laying out the camp the following rules as to the locations of tents should be followed:

Tents for sleeping quarters should be arranged in rows so that the surroundings can be more easily kept clean and permit of the use of a wagon therefor.

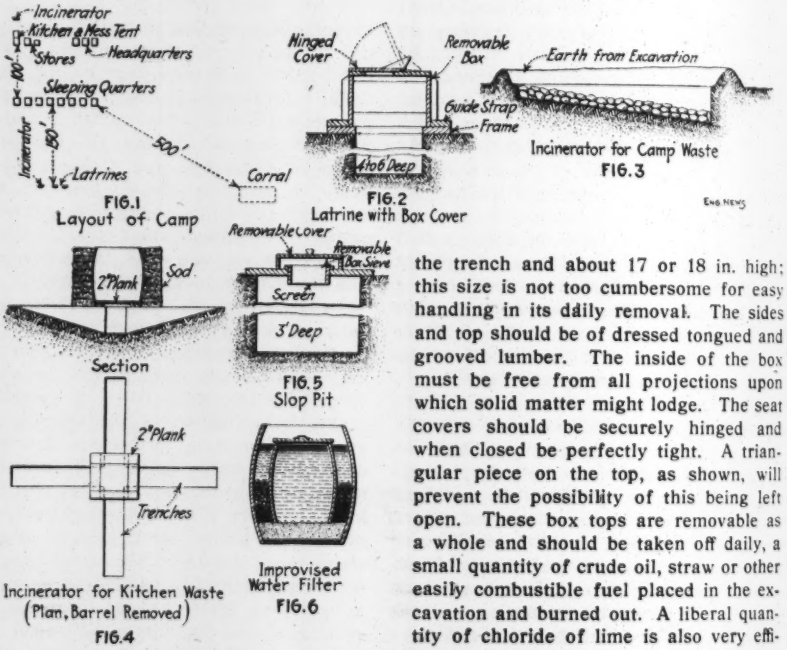
The kitchen, mess and storage tents should be at least 100 ft. from the sleeping quarters.

The stable or corral should be at least 500 ft. from any tent—farther if practicable. The distance cannot be too great from the flyless standpoint, as the stable is a great breeder of flies, and it is the breeding places that are the enemies of the flyless camp.

Latrines should be placed not less than 150 ft. from the sleeping quarters and not less than 250 ft. from the kitchen and mess, and so situated that the natural drainage shall be away from the camp.

Garbage incinerators should be placed about the same distance away as the latrines. Incinerators for kitchen garbage, and also slop pits, may be placed somewhat nearer the kitchen.

Fig. 1 shows what the writer considers an ideal camp. In many cases this arrangement will not be practicable, owing to lack of room, but if the contrivances which are described later are well made and properly used the camp may be greatly contracted. The sanitary arrangements described are such as may be provided at small expense and do not include any patented or manufactured article. Most of them have been used by the U. S. Army in the field and have proved successful.



F16.1 Layout of Camp

F16.2 Latrine with Box Cover

Incinerator for Camp Waste F16.3

F16.5 Slop Pit

Incinerator for Kitchen Waste (Plan, Barrel Removed) F16.4

F16.6

Figs. 1 to 6. Plan and Details of Sanitary Arrangements for Camp

It seems to be the silly custom in the United States to screen our houses, when as a matter of fact we should screen our stables—for our long-pencilled statisticians tell us that for each fly we allow to be brought to life in May, there will be untold millions to be kept out of our houses in August. As in a camp we have no stables to screen and the effectual screening of tents is a costly and difficult undertaking (the kitchen and mess tents only should be screened), the whole matter resolves itself into properly disposing of everything in which flies might breed. And as it is a notorious fact that flies breed only in filth, it resolves itself still further into the simple elimination of filth—to which no one can object. The most difficult part of the whole matter is the financial objection of the "boss."

The sanitary appliances of a camp are for the disposal of (1) human waste, (2) camp waste, (3) kitchen waste, and for the protection of (1) food supplies, (2) water-supplies.

1. Human Waste—First of all to be considered are the latrines for the disposal of human waste. The most simple of these is an open trench, which is gradually filled with the excavated material as fecal deposits are made. This form should be used only in camps of one or two days' duration. A more elaborate and better form is shown in cross-section by Fig. 2. In this the principal thing to secure is tightness—light-tight and fly-tight. The trench for this latrine should be from 4 to 6 ft. in depth, 2 ft. in width and about 8 or 10 ft. in length. The latrine boxes should be made to cover the trench and about 17 or 18 in. high; this size is not too cumbersome for easy handling in its daily removal. The sides and top should be of dressed tongued and grooved lumber. The inside of the box must be free from all projections upon which solid matter might lodge. The seat covers should be securely hinged and when closed be perfectly tight. A triangular piece on the top, as shown, will prevent the possibility of this being left open. These box tops are removable as a whole and should be taken off daily, a small quantity of crude oil, straw or other easily combustible fuel placed in the excavation and burned out. A liberal quantity of chloride of lime is also very efficient. Handles should be placed on each end for lifting. In one end of the box should be placed a urinal pipe and funnel with a spring flap cover.

For the collection of human waste at night small urinal cans should be provided and placed along the camp street. These should be emptied each morning into the incinerator (described later), thoroughly washed and the bottom covered with milk of lime.

2. Camp Waste—This includes all waste paper, old shoes and clothing, and the thousand and one other things which the men will throw away. For the collection of this each tent should be provided with a small garbage can with a tight cover, *which must be kept on.* As it is essential that all waste, especially perishable waste, such as banana skins, etc., should be immediately deposited in the can, it might be well to appoint one man in each tent to see that this is done, pay-

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ing him a small sum extra for the service. At least once a day these cans should be emptied, the collections burned and the cans washed out.

An incinerator for the destruction of this waste can be easily constructed. The U. S. Army "Field Service Regulations, 1910," describes this incinerator (Fig. 3) as follows:

> A pit is dug about 5 ft. long, 2½ ft. wide, 6 in. deep at one end and 12 at the other; the excavated earth is banked around the pit and the latter is then filled with stones on which a fire . . . is built; when the stones have become heated liquid refuse is poured into the pit (shallow end) where it gradually evaporates; solid matter is burned on the fire.

For stable manure a large pit should be dug and all collections burned therein by the addition of straw or a small amount of crude oil. This should be done daily.

3. KITCHEN WASTE—Incinerators for the destruction of kitchen garbage may be constructed similar to the above. Another form (Fig. 4) is made by digging two trenches to form a cross; each trench about 10 ft. long, 1 ft. wide and varying in depth from zero at the ends to about 18 in. in the middle. Over the intersection of the trenches place an old barrel with the ends removed, supported by planks placed over the trenches. The sod removed from the trenches is placed around the barrel to the full height. A fire is then built under the barrel and garbage burned thereon. The ends of the trenches should be covered (except the one in the direction of the wind), so that a good draft is created through the barrel. This is intended primarily for the disposal of solid matter only, but may be modified for liquids also by digging deeper at the intersection and filling with stones. Liquids should be poured in from the trenches. This incinerator is described in the "Manual for Army Cooks, 1910."

Liquids may be strained from the garbage before burning and deposited in a slop pit, as shown in Fig. 5.

If the camp is one of but a few days' duration all kitchen waste may be buried in pits.

PROTECTION OF FOOD SUPPLIES—All perishable food supplies must be protected from putrefaction and flies. In isolated localities where ice cannot be obtained a box buried in the ground in a shady spot will do much toward preventing putrefaction. Porous bricks soaked with water and wrapped in a wet cloth, will, by evaporation, keep butter, eggs, milk, etc., sufficiently cool, if the food is placed upon them in a shady spot. Fresh meats, which are usually secured daily, should be hung up in a screened inclosure.

If it is possible to secure ice, a suitable improvised icebox can easily be made by placing a small box inside a large one and filling the space between with hay, straw, sawdust or any good nonconductor. Each box should be provided with a cover so as to secure an air space at the top, and holes bored in the bottom for drainage.

PROTECTION OF WATER-SUPPLIES—The matter of water-supply should be carefully attended to, especially as to its source. If water is turbid an improvised filter is easily made, as shown in Fig. 6, of two barrels of different sizes. This cannot be relied upon to remove all bacteria, so water which may possibly be contaminated should be boiled and aërated before using. If no ice is to be had water may be cooled by evaporation to a great extent by keeping it in a canvas bag hung in the shade and breeze.*

MISCELLANEOUS—At all places where water is used for washing the earth should be dug up and replaced with a foot or two of gravel to facilitate percolation. No water should be allowed to collect and become stagnant.

The only tents that should be screened are those used for cooking and eating. The floors of these, if of earth, should be well packed and oiled, so they may be kept free from dust and scraps.

The arrangements described above are very simple and inexpensive, and require but little attendance. Much more elaborate schemes can be devised, of course, but for camp purposes no more efficient. The process of keeping the tents and their surroundings clean will be more or less difficult to initiate with the average gang of laborers, but once the spirit of cleanliness is inculcated the several tents will vie with each other in presenting the neatest appearance.

To illustrate the advantage of the introduction of camp sanitation, some statistics taken from an article by Major General W. H. Carter in the *Outlook* of Dec. 23, 1911, will be interesting. During the Spanish-American War, 10,759 men were encamped at Jacksonville, Fla. The number of deaths was 281, of which 248 were from typhoid fever. No inclusive dates were given by General Carter, but the writer's recollection is that the camp was for a period of about six months, which would make a yearly death rate of 46.1 per 1000 from typhoid. At San Antonio, Texas, last year, for a period of four months, 12,801 men were encamped. The deaths from all diseases numbered but 11, none of these being from typhoid. At San Antonio the sanitary orders were very rigid; at Jacksonville, orders were very slack or lacking, apparently. The result, by inference, was the very high death rate at Jacksonville and the most remarkable showing made at San Antonio.

At Galveston, Tex., some 4000 men were encamped and sanitary precautions were taken with about the same results as at San Antonio.* And this, too, in an extremely humid and hot climate on badly drained ground.

Aside from the fact that these precautions are preventors of epidemics, they are also factors in cost reduction. In the vicinity of some camps which the writer has seen the time lost by the men brushing and swatting flies would offset many times over the cost of efficient sanitation as described. The new "efficiency engineer" with his notebook and stopwatch would be kept busy making such notes as "10:03 to 10:03½, brushing flies."

Contractors and engineers alone are notoriously behind in the national "swat the fly" movement. Hasn't the time arrived to get busy?

The Brain of Dr. W J McGee, willed to Dr. Anthony Spitzka, the noted Philadelphia brain specialist, for research study, has been announced by him to have a weight of 1410 grains, or slightly over three pounds, which places it among the 100 heaviest brains so far investigated. Dr Spitzka's very interesting studies, on the brains of some of the most noted men of recent years, have led him to the conclusions that the weight of the brain is very closely dependent on the field of activity in which it is used, and that the brain grows in size and weight under heavy service and seems also to lose in size and weight under light service.

The Decomposition of Concrete by gypsiferous water is noted in an article by J. D. Howkins, entitled "Extension of the Old Pier at Hartlepool" which is paper No. 3961, from the Minutes of the Proceedings of the Institution of Civil Engineers. The article describes the construction of a new pier head at Hartlepool, Eng., in which for the most part, large concrete blocks were used. The author says:

> A firm foundation on clay was met with, except at one point on the inside of the pier, where the black color and the smell of the mud between the large boulders suggested the presence of a sulphur spring. It had been previously ascertained that, when repairs to the old head at this point had been carried out, the concrete used rapidly deteriorated, this being the only instance which has come under the observation of the author of concrete made from sound materials suffering from other than accidental causes in a sea-work. By the courtesy of Messrs. Otto Trechmann, the local cement manufacturers, two analyses were made: the first, of some concrete which had deteriorated when brought into conjunction with this mud, and the second of the mud itself. These analyses indicated that the presence of the black mud itself did not cause the deterioration of the concrete, but that this was brought about by gypsiferous water from a bed of anhydrite and gypsum which occurs in the magnesian limestone below the harbor, and abuts against that rock beneath the boulder-clay near the end of the Old Pier. It is interesting to note, first, that the old inhabitants of Hartlepool used to obtain a medicinal water near the Old Pier, and secondly, that Messrs. Otto Trechmann, when boring at their works about a mile distant, met with this same gypsiferous water after piercing 265 ft. of anhydrite. It was of course considered undesirable to use concrete for this part of the foundation, and large blocks of stone were substituted.

*The method of cooling water works particularly well, of course, in dry climates. Even in a humid climate, however, evaporation is considerable, especially if any wind is blowing. A canvas bag filled with water and hung on an automobile or motor boat where the wind strikes it will afford refreshing drink.—Ed.

*Account should be taken of the anti-typhoid treatment given the soldiers at one or both these Texas camps.—Ed.

Future Uses of Solar Energy

Under the title "Photochemistry of the Future," a lecture was given in New York City on Sept. 11 before the International Congress of Applied Chemistry by Giacomo Cimician, of Bologna, Italy. This was an interesting forecast of various solutions, which may be expected, of the problem of securing energy for industrial processes after the present stores of fossil fuel are depleted.

The lecturer started with the assumption that the earth received from the sun three gram calories per minute per square centimeter of exposed area, and he developed from that figure a statement (figures converted from metric to English units) that we receive each day from the sun on a square yard, with a tropical day of six hours, an amount of heat equivalent to that in about 1.8 lb. of coal. For a square mile this heat would be equivalent to the combustion of 2600 tons of coal. The quantity of coal and lignite produced in Europe and America being some 1,100,000,000 tons a year, an area of less than 12,000 sq.mi. receives solar energy equal to that in the world's coal output for a year. The Desert of Sahara receives *each day* on its 2,000,000 odd square miles, the equivalent of 6,000,000,000 tons of coal.

This enormous amount of energy is largely wasted; what is utilized is through waterfalls and plants. The water-power energy of a year is equal to 70,000,000 tons of coal—only a slight proportion of that sent here by the sun. On the total surface of the continents (50,000,000 sq.mi.) there is a yearly production of 32,000,000,000 tons of vegetable matter equivalent to 18,000,000,000 tons of coal —seventeen times the present fuel production.

It was held conceivable that the production of organic matter might be increased in general and intensified in places, together with such a regulation as to produce abundant sources of energy or useful products. By increasing the concentration of CO_2 up to an optimum value of from 1% to 10%, it seemed possible that the production of organic matter might be largely increased, making use of suitable mineral fertilizers and selecting localities with proper climate and soil. The harvest of vegetation (sun-dried) should be converted most economically into gaseous fuel, taking care to fix the ammonia, as by the Mond process, for return to the soil as nitrogeneous fertilizer together with all the mineral substances in the ash.

In this way, it was held, a complete cycle could be maintained with only the slight waste common to all industrial processes. The gas from the fuel needed to be burned entirely on the spot, as in gas engines, and the mechanical energy needed to be transmitted elsewhere or utilized as seemed desirable. The carbon dioxide from the combustion needed to be returned to the fields.

There was described a further problem in the utilization of plants. First, it was necessary to remember that industries based on agriculture, such as for the production of cotton and textiles, starches, alcohols, fats, sugars, hides, etc., were susceptible of improvements by the introduction of more advantageous technical devices and by the increased production of raw materials.

Plants are unsurpassed workshops for the photochemical synthesis of fundamental substances, building them up from CO_2 with the help of solar energy. They also produce secondary substances usually found in small quantities but of value for special reasons; the alkaloids, glucosides, essences, camphors, rubbers, colors, etc., are of even greater interest than the fundamentals because of their high commercial value.

Up to the present, products from coal tar have always been triumphant. But the chemistry of benzine and its derivatives does not now constitute the favored field of scientific research as it did during the second half of the last century. The center of interest is to be found in problems of biology. This new direction in the field of pure science is bound to have its effect on the technical world and to mark out new paths for industrial progress.

It is a fact that several organic industries have been successfully developed outside of the field of benzine and coal tar. There are flourishing industries in essences and perfumes and in some alkaloids like coca—all products which plants produce in relatively large amounts and are converted into products of higher commercial value.

The question has still another side which deserves attention. This concerns certain experiments recently made with Prof. Ravenna at Bologna. No practical results have been secured, but they show definitely that the chemical processes of plants can be modified to a certain extent. In a series of experiments made to determine the physiological function of the glucosides (compounds which by hydrolytic decomposition yield sugars, etc.), these were obtained from plants that usually did not produce them. Through suitable innoculations it was possible to force maize to synthesize salicine (a glucoside). While studying the function of the alkaloids in plants, the production of nicotine in the tobacco plant was modified so as to obtain a large increase or a decrease in quantity.

There is no danger of using, for such industrial purposes, land which should be devoted for raising food stuff. An approximate calculation shows plenty of land for both purposes, especially when the various cultivations are properly intensified and rationally adopted to soil and climate.

The question may be asked whether there are not other methods of production to rival the photochemical processes of plants. Photochemical processes so far have had no extensive practical application outside of photography, which, however, represents only a small part of photochemistry. Chemists have been attracted by more urgent problems so that thermochemistry and electrochemistry have reached a high degree of development while photochemistry is in its infancy.

Photochemical reactions follow fundamental laws of affinity, but have a special character. They are notable for the small temperature coefficients, but are, however, comparable to reactions which take place at very high temperatures. The fundamental problem from the technical point of view is how to fix the solar energy through suitable photochemical reactions. To do this, it would be sufficient to imitate the assimilating processes of plants such as the transformation of CO_2 of the atmosphere into starch, liberating oxygen and reversing the ordinary processes of combustion. It has always seemed probable that formaldehyde was the first product of the assimilation, and Curtius has demonstrated its presence in the leaves of beech trees. The artificial reproduction of a similar process by means of ultra-violet light has been obtained by Berthelot.

The true solution consists in utilizing radiations that pass through the entire atmosphere and reach the surface of the earth in large amounts. A way of accomplishing this exists in plants. By using suitable catalyzers it should be possible to transform mixtures of water and CO_2 into oxygen and methane, or to cause other endo-energetic processes. The desert regions of the tropics where the soil and climate make it impossible to grow ordinary crops could be made to utilize the solar energy which they receive in so large a measure all the year; the energy thus derived would be equal to that of billions of tons of coal.

Besides such simple processes, which would give new value to the waste products of combustion, several others are known to be caused by ultra-violet radiations and these might eventually take place under the influence of ordinary radiation provided suitable sensitizers were discovered. The synthesis of ozone, sulphur trioxide, ammonia, oxides of nitrogen, etc., might become the object of industrial processes.

In the field of organic chemistry the reactions caused by light are so many that it should not be difficult to find some of practical value. The action of light is especially favorable to processes of reciprocal oxidation and reduction, which give rise to, or are associated with, phenomena of condensation (the combination of two molecules of a given com-

pound to a single molecule of a second compound by condensation). The common condensation is that of the aldolic type (acetaldehyde, CH_3CHO, to aldol $C_4H_8O_2$) and there is much hope for the future, since this is the fundamental reaction of organic synthesis.

A new field in the photochemical production of artificial colors and dye stuffs is foreseen. The scope of studies on this subject ought not to be limited to preserving colors from fading, bleaching, and all changes produced by light. The photochemistry of colors and dye stuffs ought to furnish new methods of preparation and of dying. Phototropic substances, which often assume varying intense colors in the light and afterward return in the darkness to their primative color, might be used very effectively. Such substances might well attract the attention of fashion rather than fluorescent materials which give the impression of changing colors. The dress of a lady so prepared would change its color according to the intensity of light. Passing from darkness to light, the colors would brighten up, conforming automatically to the environment—the last word of fashion for the future.

Solar energy is not evenly distributed over the surface of the earth. There are privileged regions and others less favored by the climate. The former would be the prosperous ones with utilization of solar energy. The tropical countries would be conquered by civilization which would return to its birth-place. Even now the strongest nations rival each other in conquest of the lands of the sun, as though unconsciously foreseeing the future.

On arid lands there would spring up industrial colonies without smoke and without smokestacks. Forests of glass tubes will extend over the plains and glass buildings will arise everywhere.

If the supply of coal becomes completely exhausted in a distant future, civilization will not be checked by that, for life and civilization will continue as long as the sun shines. If this black and nervous civilization based on coal should be followed by a quieter one based on the utilization of solar energy, that would not be harmful to progress and happiness.

The Heaviest Locomotives of American and foreign railways are compared in a note in the London "Times." It mentions the Mallet duplex compound locomotives of the Virginian Ry., which weigh 241 gross tons (336 tons with tender), and have a load of 222 tons on the driving wheels. The heaviest engines built by two of the leading locomotive companies in England are 96 tons (143 tons with tender) and 81 tons (146 tons with tender), these being, respectively for lines of 3 ft. 6 in. and 5 ft. 6 in. gage. All these are for export, the first two being for lines of 3 ft. 6 in. and the third for 5 ft. 6 in. gage. The first is an articulated engine. Of tank engines, there is listed one of 120 tons (standard gage), and one of 102 tons (5 ft. 3 in. gage).

Railway Locomotives as Fire Engines on the Pennsylvania Railroad*

During the past ten years railway locomotives used on occasion as fire engines have made a remarkable record in extinguishing fires along the Pennsylvania R.R., not only on its own property but often in out-of-way places where there was no other protection to be had. This form of protection has been a gradual development until today there are 612 engines in yard and switching service equipped with this special apparatus and supervised by a well organized private fire department at all of its larger terminals, which is in addition to systems of water mains and fire hydrants at these points.

The original arrangement, which consisted of a hose connection placed in the line conveying water from the injector in engine cab to the boiler, has been improved by providing a special form of extinguisher, by which the water from the locomotive tender is discharged through an ejector by means of the high steam pressures carried in locomotive boilers.

The standard equipment for each locomotive consists of 150 ft. of 2½-in. unlined linen hose and a 15-in. cast-iron nozzle with a ⅝-in. discharge opening, kept in a box under the running board of the engine, the hose being coiled in separate sections. With this equipment engines are enabled to throw a stream of water 70 ft.

The yards are divided into districts each of which is designated by a number. When a fire is discovered a general alarm calling all engines in the particular district is sounded on air whistles installed on each switch tower. By a code of signals engineers and firemen of locomotives can tell immediately just where the fire is. Yard masters and train directors are instructed to give the locomotive clear track in reaching the scene of fire, and in cases where locomotives are moving or shifting cars, the crews are instructed to uncouple the engines and proceed without delay to the fire immediately upon sounding of the alarm—on the way to the fire connecting up the hose and preparing to get into service immediately upon arrival.

The locomotive fire-brigade organization in each yard is under the general supervision of the assistant yard master, acting as chief, and coöperates at all fires with the regular yard fire brigade, which is organized and regularly drilled at each point. The conductor of the shifting crews is designated as captain and has direct charge of his own crew in all fire operations. To each member of the crew is assigned a special duty: to the flagman, the unreeling and laying of hose line and making connections; to the two brakemen, the moving of the hose line and directing the nozzle; to the engineer and fireman, the operation of the pump and maintaining the required pressure.

The record shows that these locomotives extinguished 49 fires during the year 1911, 153 during the past four years.

*From information given by the Pennsylvania R.R.

Irrigation in Canada—At the recent annual meeting of the British Association for the Advancement of Science, at Dundee, Scotland, a paper on Irrigation and Canada was read by Sir Wm. Willcocks before the geographical section. The "London Times" gives the following report of Sir William's paper:

"He said that irrigation and marriage went together. Children and prosperity kissed each other. Children in towns were a source of expense, but on irrigated farms they were a source of wealth. Either Mormonism made Brigham Young turn his thoughts to irrigation, or irrigation turned him to Mormonism. (Laughter). Where all the laborers were members of the family there were no strikes, such as were so common here.

"Young unmarried men had not, as a rule, been a success on farms. 'It is not good for man to be alone' was as true on a farm today as it was in Eden. The Garden of Eden was an irrigated farm, with alfalfa, fruit trees, and cattle, just as in irrigated Canada, and irrigated Canada would be claimed as the Garden of Eden but for the Fall. (Laughter).

"If the money spent on expensive schools for boys and girls were put by as dowries for the girls, and the boys were taught practical farming and then married to the girls and sent to Canadian farms with a moderate capital, there would no longer be the sight of young men hanging about for odd jobs, with all the professions crowded out and so many militant suffragists making Britain the laughing stock of the world. The suffragist worry was the price which had to be paid for spending so much money on extravagant and painful education for boys, while girls had no dowries provided for them.

"Shakespeare was right when he wrote:

'earthlier happy is the rose distill'd
Than that which, withering on the virgin thorn,
Grows, lives and dies in single blessedness.'

"These dowerless women were not earthly happy; they could not be distilled; and they had made up their minds to distill mankind. (Laughter).

"He expressed great hopefulness with regard to the future of irrigated Canada, though he thought the people there, like true sons of a shop-keeping nation, rather over-advertised their attractions. Napoleon had saved this country from that spirit 100 years ago, and he thanked God that the German navy was rising into power, and that, when really formidable, it would ween Canada, as well as the people of this country, from the harlot spirit in commerce against which Isaiah pronounced his bitterest woe, and which was capable, above all others, of making a nation lose that 'title of respect which the proud man ne'er pays but to the proud.'"

Reaching the High Places, or Booster Pumps*

By H. E. Cole†

The determination of the proper pressure to be maintained in any given waterworks system is often a very difficult one and even when settled frequently results in general dissatisfaction for a large percentage of the consumers. It seems, therefore, that some time could profitably be spent in the study of ways and means of supplying the demand of those who are so located that the pressure of the system will not give satisfactory service. first cost of large mains with low friction

There are at least three kinds of consumption requiring booster service:

First—Tenants of tall buildings which are located on streets where the service is sufficient for ordinary requirements, but owing to the heighth of the building the normal pressure of the system is inadequate. In this class apparatus is usually installed by the owner of the building to boost and store a sufficient capacity for ordinary requirements.

Second—Small sections of a city's or town's population are frequently located on elevations higher than the reservoir or where the pressure is insufficient for their requirements. This is a condition which a great many companies have to face. It may be considered under seven heads.

(1) The number and class of consumers to be supplied determines the capacity of plant to be installed.

(2) The distribution of the population determines the location of the booster station and reservoir with reference to the main bringing in the supply. It furthermore makes necessary a careful study of first cost of large mains, low friction losses or of small mains and necessary increase in pressure to overcome friction head.

(3) The pressure to be maintained has a very important bearing as it determines largely the character of the reservoir to be used as well as the type of pump to be installed.

(4) The importance of uninterrupted service has its effect on both the quality of apparatus and on the duplication of units as well as on the power employed and attendance.

(5) The amount of storage required usually determines the kind of reservoir which shall be used. If the pump is to operate automatically, then the storage required may usually be very much smaller than otherwise. The determining factor, then, is the amount of storage required for fire protection or to supply the sections during the probable shutdown of the pumps or loss of power from any cause.

(6) The kind of power available materially affects the cost of operation and the adaptability of the power.

(a) If steam is the power used and coal the fuel, the coal must usually be hauled a long distance and at a high elevation, steam must be kept up most of the time. An attendant must be present practically all the time the pump is in operation. The smoke nuisance must also be contended with.

(b) Natural gas for steam, when available, is far better than coal, as hauling is practically eliminated, and there is no smoke. In such cases, however, a small amount of coal should be kept in reserve and the boiler equipped to use both gas and coal in order to be prepared for a shortage of gas or other interruption of the supply. The necessity for a constant attendant, however, still remains.

(c) Natural gas when used in an internal combustion engine to drive a power pump makes one of the best powers for this service, as the fuel cost is usually the least and mechanical efficiency of equipment is relatively high. The chief disadvantages are frequent attention required, although far less than for steam—cannot be operated automatically without serious complications, although it is not only possible, but entirely practicable to make the pump operate automatically, as required, by keeping the engine running continually. Whenever gas engines are used it is good policy to provide gasoline attachments so that the engine could be operated on gasoline or other liquid fuel on very short notice.

(d) Gasoline or other distillate when used in an engine is to be recommended when gas or electricity is not available and where the amount of water to be pumped is small, as the fuel cost is usually high. The advantage of this power is that, as a usual thing, the pumping unit can be started and operated at full capacity in a few minutes, ten minutes being a fair average. The objections are much the same as previously stated for gas, but there is the additional disadvantage of hauling and storage of the fuel and dangers of explosions in or near the buildings.

(e) Crude oil engines are rapidly being perfected and placed on the market which materially reduce the fuel cost, but require a little more time to start up than either the gas or gasoline engine.

(f) Electricity is very nearly an ideal power for this service, provided that an attractive rate can be obtained and the service is reliable for 24 hours each day.

A combination of any of the above powers may be used to advantage depending upon the demands of the particular case.

(7) Accessibility by the attendant in charge materially affects the selection of equipment and cost of operation. If the amount of water to be pumped is only moderate, plant difficult of access, and electricity is available, it is desirable to keep cost of attention to a minimum; therefore make plant as nearly automatic as possible.

The location of the booster station depends entirely on local conditions. All things being equal it should be located at the main reservoir from which the supply is taken. It is also preferable to have the pump so located that water will flow to it by gravity from the main reservoir. This insures the pump being primed at all times and eliminates the danger of getting air into the line.

When the section to be supplied is so situated that it is inadvisable to locate the booster pump at the reservoir, it should be located on a prominent main at a level which will positively assure a good supply on the level of pump intake.

A large vacuum chamber as well as an air chamber should be used on reciprocating pumps and a large air chamber would show good results even with a centrifugal or rotary pump.

In locating the booster plant attention should be given to the discharge. It is always preferable to use an independent line from pump to booster reservoir. Pulsations and noises are easily felt on lines from which service is given. Pulsations can be very materially reduced by the use of a large air chamber depending entirely on the type and capacity of the pump and the velocity of water in the line. Greater efficiency can be obtained from this air chamber if air can be supplied to the chamber to increase the relative proportion of air to water.

Noises can be reduced by the use of special gaskets or lead nipples. In some very bad cases it can be cured by using a short section of hose in the discharge between the pumps and the discharge main.

In both of these respects the advantage of using an elevated tank or standpipe or hydro-pneumatic pressure tank near the pump is very evident.

Third—The third class of service is where the regular line pressure is sufficient for domestic consumption, but insufficient for proper fire protection to fulfill the requirements of the company's charter. The method of treatment, however, would be so nearly the same as for the second class that no additional suggestions will be given for this class.

Since the cost of attendance is one of the chief items of operating expense in a plant it is very desirable to reduce this expense to a minimum.

If an attendant is required all the time the pump is in operation it is generally good practice to install equipment of large capacity to reduce this item of expense. This means, however, larger mains and larger storage capacity.

*Condensation of a paper and discussion before the Central States Water Works Association, September, 1912.

†Vice-President and Chief Engineer, Harris Pump Supply Co., Pittsburgh, Penn.

It would therefore seem desirable to keep line and reservoir cost down by pumping much of the day at a lower rate per hour, leaving only enough reserve to take care of ordinary increase in consumption, or falling off of pump capacity and giving ample time for ordinary repairs. To do this and still keep down cost of attendance requires apparatus as nearly automatic as possible.

With steam equipment, an attendant is necessary on account of the use of boiler, but if steam is taken from some other source so that the pump is the only part requiring attention then it should be the aim to provide a reliable source of lubrication and control speed of pump automatically. The simplest control is by a pressure regulator where the difference between starting and stopping pressures is fully 10% of the stopping pressure in the line and exclusive of the friction head. Where the line is a long one and the pump comes up to speed very rapidly it will be noticed that the pressure required to accelerate the water in the line from its state of rest to its regular velocity, momentarily runs the pressure far above the maximum or stopping pressure of the system. Ordinarily this would cause the automatic control to act and stop the pump and this pressure being only temporary, the pump would again start and the result would be a rapid alternation of stops and starts. This can be overcome by the use of a tank, of about 50 gal. capacity, to which pressure connection is attached. This connection should be made from discharge main to tank, so that the rate of flow from one to the other would be very small, namely, 1 or 2 gal. per min.; then with sufficient air compressed in top of tank so that it is ordinarily half full of water; it will be noticed that the pressure is very slow to respond to changes in the main line pressure and the temporary pressure due to starting is passed, and normal is restored before the tank shows any appreciable change.

Where the increase of pressure due to accelerating water in the line is high enough to endanger the pump or other equipment, a relief or safety valve should be installed to take care of the excessive pressure.

Where the difference in pressure between starting and stopping is less than 10%, most regulators are unreliable, due to back lash and lost motion in the springs and other mechanisms. In such cases an artificial head can be produced, which, if the flow of water from the pump were constant, would cause sufficient difference in pressure to cause the controlling mechanism to operate, I believe, within 2½% of the shutting off pressure.

If this were carried out by the use of the tank described above and the introduction of sufficient friction in the discharge of pump to the discharge main, it would with regular line friction make the necessary difference required. This plan could not be successfully used with centrifugal pumps due to the varying capacity of pump under different conditions. In any case the power required for pumping would be increased by approximately the same amount as the increased pressure, still this amount would be very small compared with the saving effected.

The automatic control of steam pumps by float from the surface of the water in the reservoir is so complicated that circumstances would seldom justify it.

Electric pumps are by all means the easiest to operate automatically, first, because an electric pump can be provided to operate continuously with practically no attention, and second, because electricity can be transmitted so easily. Stopping and starting can be easily performed by the rise and fall of water in a reservoir several miles away by means of a float and solenoid switches.

Pressure control is, however, always preferable, as the controlling apparatus is then under the same roof with the pump and the motor and the danger from ice, storms, etc., which exists with floats, chains, etc., is eliminated.

Gas or engine automatic control is difficult owing chiefly to the fact that most engines have to be started by some external power, and this is difficult to accomplish from a remote point. Partial operation, however, may be obtained by keeping the engine in continuous control properly governed and well lubricated and with an automatic pressure regulator, pressure being taken as previously described. This regulator would operate a control attached to level of a friction cut-off coupling so that the pump would therefore be started and stopped as desired. Float control would also be difficult by this method.

Another method of partial control would be by connecting up the ignition circuit of the engine with a pressure regulation or with a float switch. Then the engine could be stopped when the reservoir was filled, but could be started again only by an attendant. In this case a magneto should be used instead of batteries, for when the pressure fell to the starting point, it might short-circuit the batteries and run them down.

DISCUSSION—C. B. Salmon, of Beloit, Wis:, said that experience with two or three booster installations, one at a mine in West Virginia, had shown the electrical centrifugal pump to be easy to operate and very effective.

L. A. Tonkel, of Alliance, Ohio, gave substantially the following account of a booster station in his city:

Our main pumping station is located about 240 ft. lower than the highest point in Alliance, and there have been days and days when everybody was sprinkling in extreme dry weather when the people at the highest point could not get any more than 10 lb. pressure, although we had 240 lb. pressure at the plant. The question arose of how to relieve that condition, which had existed for twenty years until people were getting tired of it. This hill was the finest location and best residence portion of Alliance, and they wanted water in those fine homes. I suggested years ago that we lay a 12-in. or 14-in. line from the town up to Mount Union, and put in a separate pump and pump to them direct just the same as if we were supplying two separate towns; that we have one pump for that hill and another for Alliance proper; but we found that would cost the city $300,000, and that was thought to be too much. So instead of doing that, last spring we installed a booster pump just half way between the lowest point and the highest point. At our lowest point we carry 125 to 130 lb. at the pump house.

I start the pump at the booster station by electricity at 5 a.m., and at 7:30 p.m., it is shut down. I have a 12-in. valve between the inlet of this pump and the outlet. That gives them water in case of fire over night. When I start the booster pump I shut that valve off. When we get through with our improvements we are going to have two standpipes, one 60 ft. high, to supply the low pressure, and another one 100 ft. high, to supply the high pressure. When the standpipe is full on the high-pressure line the pump will shut itself down, and stay shut until we use 20 ft. After that the pump will start automatically. That is the way we have ours arranged. We ran it for one month for 3c. per kw.-hr.

Several who discussed the paper spoke favorably of electrically-driven pumps.

In response to numerous suggestions and requests Mr. Cole promised to supplement his paper with figures of costs and other data which would assist waterworks superintendents in deciding on the advantages of using booster pumps and aid them in choosing the best plan to meet local conditions.

The India-rubber Industry in Brazil has been the subject of two bills passed by the Legislative body of that country during 1912. The first measure dated Jan. 5, provides for the furnishing of aid, both direct and indirect, to enterprises which are formed for the development of the country's rubber bearing trees, or for the carrying on of such other industries as are incidental to that development, and to the maintenance of workers on the rubber plantations. The second act, dated April 17, embodies the regulations for carrying out the provisions of the earlier law, and goes into a detailed statement of the exact limits of that law and the exact method in which it is to apply, dealing at length with the rubber producing industry itself, and also with the development of railway facilities, navigation, and settlements which must accompany the growth of that industry.

Dynamiting an Unsatisfactory Concrete Arch

A partially completed concrete arch bridge at Oakville, Ont., the construction of which was unsatisfactory to the engineers in charge, was dynamited on Aug. 13, 1912, and all the structure above the foundation removed to be replaced by a new arch. From Frank Barber, Toronto, Ont., the consulting engineer on the works, we have obtained information from which the following description of the destruction of the arch ribs has been prepared.

FIG. 1. CONDEMNED CONCRETE ARCH RIBS JUST PREVIOUS TO BEING DYNAMITED

The condemned concrete formed a part of a reinforced-concrete viaduct over a creek on the main road between Oakville and Trafalgar. The viaduct as designed is 476 ft. long and has a 16-ft. roadway. It comprises eight girder spans of 35 to 48 ft. approaching a spandrel arch bridge over the main channel with a clear span of 135 ft. and a rise of 38 ft., the roadway elevation being about 50 ft. above low water. This main arch was to consist of two arch ribs of uniform width and 3 ft. 3 in. square at the crown, with a depth of 5 ft. 6 in. at the skewback. The roadway, a reinforced-concrete slab, was to be carried on these ribs by spandrel columns braced with cross-beams.

The substructure to this arch, two solid concrete footings, was built to the satisfaction of the consulting engineer, but he could not approve the design or construction of the timber centering upon which the arch ribs were to be built. It was computed that the main centering as built, mostly of green pine, would have to resist about 1000 lb. per sq.in. compression from the weight alone of the concrete in the two ribs. The engineer considered this centering would not be rigid enough or strong enough under such a pressure and ordered it strengthened before the work of concreting proceeded. This the contractors refused to do and began concreting the arch ribs without strengthening the centering and before the engineer had a chance to have them adjusted to correct curvature and alignment. Upon investigation it was found that the arch curvature was approximately correct, but the center line of the ribs departed from a vertical plane at many points, the maximum departure being about 2¼ in.

Thereupon the consulting engineer withdrew his inspector, notified the contractors that they were dismissed and applied for an injunction to stop the work. This injunction was granted, but upon a later application for its continuance the contractors were allowed to complete the ribs at their own risk. This concreting the contractors did with the engineer having no supervision, but with his representative on hand to take observations.

The ribs were concreted in voussoirs about 6 ft. long with short spaces between, afterward filled as keys. When only part of the concrete was laid, settlement occurred at different places, the maximum being about 3 in. The contractors then strengthened the centering in the manner previously ordered and no further settlement occurred. However, beside the settlement during the concreting and the poor alignment noted there were other faults noticed by the engineers; among these were the injury of the concrete by frost for several inches in from its surface, particularly at the crown, and the fact that spading and puddling of the concrete was not done according to the agreement. This latter the engineers thought most necessary because the concrete aggregate was somewhat separated from the mortar after being poured down chutes.

As the extreme fiber stresses of the concrete in compression for certain combinations of loading and temperature were computed analytically to be nearly 700 lb. per sq.in. in the skewback and only slightly less in the crown, the engineer considered that the very best of concrete was necessary in the arch ribs. This high-class concrete was not obtained and the engineer refused to accept responsibility for the strength of the arch. The case between the contractors and the County of Halton, which was building the bridge, was settled by the contractors being paid cost plus 10% for all their work which was accepted by the engineer, but nothing for the rejected arch rib, including the centering and forms. The contractors further conveyed to the county the centering and forms for these ribs upon the county agreeing to have them taken down at its expense. The cost to the contractors for the ribs including falsework was about $3000.

When the contractors left the work the arch ribs were complete with one cross-beam at the crown. It was decided that the safety of the structure demanded the entire removal of all the work above the foundation. In dynamiting the arch this cross-rib was first cut clear through and the arch ribs themselves cut through the surface concrete and the steel reinforcement at three places, at the crown and at each skewback. (See Fig. 1.) This reinforcement consisted of 16 round rods ¾ in. in diameter along the intrados and the extrados of each arch rib. Charges of dynamite were then placed around each rib in the kerfs and each rib blown down separately, all three charges being exploded simultaneously. The method was very successful, the arch-rib material being thrown into the river bed, practically under its position in the arch. A view of the destroyed structure is shown in Fig. 2.

Work has started on the reconstruction of the arch and the remaining por-

FIG. 2. VIEW OF ARCH RIBS AFTER BEING BLOWN DOWN

tions of the viaduct and will probably be completed before the beginning of the new year. The county engineer in direct charge of the work is James Hutcheon, and Frank Barber, Toronto, Ont., is consulting engineer.

The Twentieth Annual Irrigation Congress Held at Salt Lake City

(CONTRIBUTED)

Engineers and others interested in the development and use of the water resources of the arid region will find in the proceedings of the 20th Irrigation Congress, held at Salt Lake City, Utah, Sept. 30 to Oct. 3, a number of interesting and suggestive papers relating to methods of storing and distributing water to irrigators, development of power, and particularly the use of power in pumping water for irrigation.

The 21st anniversary of the origin of the Congress was celebrated at the place of its birth, Salt Lake City. The meeting was really the twentieth, as one annual meeting had been omitted. The occasion also marked the tenth anniversary of the passage of the Newlands Bill or Reclamation Act as it is now called, introduced originally by Senator, then Representative, Newlands, of Nevada, and signed by President Roosevelt on June 17, 1902. Very appropriately Senator Newlands was the President of the Congress and was the central figure in its deliberations.

Attendance on the Congress was especially good from Utah and adjacent states, but there was perhaps not as much enthusiasm as at some of the earlier congresses, due to the absence of the promoters of irrigation schemes who were prominent in earlier congresses. The recent depression and doubt concerning the value of irrigation securities has served to clear the field of many of the extreme optimists who have been very prominent in past congresses. The discussion was characterized by a more complete realization of conditions and a more businesslike determination to meet these conditions fairly and squarely. The period of irrigation booms has now passed, and there is a better understanding of the dangers which have to be surmounted and a better appreciation of the benefits which will ultimately be derived.

One of the large contributing factors to this better understanding of the subject has been the work of the Reclamation Service, which in ten years has expended upward of $75,000,000 on over a score of irrigation projects and has kept careful records of the actual cost of the construction, and also of the operation and maintenance of those portions of the irrigation systems already built. This has cast a strong light upon the dark corners and has enabled a better understanding by the public of the true cost of such works, so that it is no longer for the promoter to impose upon the ignorance of the public in exploiting visionary schemes, or rather there is no longer any excuse for the financier or investor to be misled as to the real conditions.

With this increase of knowledge has come a better realization not only of the cost of building, operating, and maintaining large irrigation systems, but also of the benefits to be derived and the dangers to be encountered. It was shown by census figures and general information that the average value of the crops produced is entirely too small to justify further large works. On the other hand, it was shown at the Congress that large crops can be produced and are being produced by say 20% of the irrigators, and that with better methods of agriculture and better facilities for marketing, there is every reason to continue to extend the irrigated area.

At the same time it was pointed out that irrigation, especially from large works provided with ample water through storage, is accompanied by the need of adequate drainage, exactly in the same way that a village when provided with a proper water supply must immediately have a sewerage system. The earlier irrigated areas, stretched in a narrow ribbon along the streams, were not particularly liable to swamping, but with great compact areas of fifty to one hundred thousand acres, provided with ample water, a considerable proportion of the best farming land, which first produced the biggest crops, is being swamped. For example, it is stated that in Salt Lake Valley and in the whole State of Utah possibly 25 per cent. or even 30 per cent. of the good irrigated land is now either already ruined or is liable to great injury.

Similarly in the San Luis Valley, of Colorado, it is stated that 500,000 acres, embracing some of the best farms in Colorado, have been ruined by excessive application of water. The resulting injury is appalling unless one considers that the remedy is relatively simple and lies within the reach of many communities, namely, the prevention of excessive application of water and stopping of waste.

Some of the many striking statements were those made by agricultural investigators, notably Dr. J. A. Widtsoe, President of the Utah State Agricultural College, who showed that the largest crops were produced with the most sparing use of water; that with a certain amount applied to one acre, fair crops might be had; with the same amount applied to two acres, better crops, and that with proper use of water, four times the area may be cultivated with the present water supply and with a crop production per acre in excess of that now attained.

The subject of providing water by pumping was also discussed in a number of papers and informally. It was brought out that the future extension of irrigation is limited by the cost of pumping rather than by ability to obtain a gravity supply, and it was also emphasized that the man who is using pumped water for irrigation is economizing in the use of water and is producing the most valuable crops. Thus under a pumping system the evils of excessive use of water are brought to a minimum.

In advance of the Irrigation Congress there was held a meeting of delegates from various water users' associations in areas which are being irrigated by the government. These delegates, representing 17 of these associations, formed an organization to be known as the National Federation of Water Users' Associations. The principal object of coming together appeared to be that of securing an extension of time for repayment of the cost of the projects to the government, the argument being that these costs are excessive. The delegates were for the most part lawyers or professional men, relatively few being actual irrigators, and in their selection illustrated one of the dangers of popular organizations attempting to handle large technical matters. It appears that the average farmer under irrigation is too busy on his farm to attend frequent meetings and to discuss the affairs of the project, but is apt to let the control drift into the hands of the type of farmers who spend much of their time in town discussing politics, socialism, etc. These men, desiring public recognition, are apt to be elected to the offices, but are not really representative of the sentiments of the great body of people who elect them rather through indifference than as the result of thoughtful action.

The delegates chosen from among these officers represent many extreme views. Some apparently desire extension of the term repayment to twenty years, others to thirty years; others urge that there is no necessity of repaying the amount to a wealthy government. There were, however, a number of careful and conservative men in the group, and after several days of discussion the resolutions produced were comparatively mild, being confined mainly to the question of extension of time for payment and to the desirability of securing better men in the management of the projects; also of turning over the projects at the earliest possible date to the water users to be operated.

The resolutions adopted by the Federation were presented to the Irrigation Congress, but were accepted only in part and in very modified form, the consensus of opinion of the Congress being decidedly antagonistic to repudiation of the debt owed to the government and unfavorable to unsupported criticism of the agents of the government who have been handling the work.

During the meeting of the Congress,

also, there were held from time to time informal conferences of state and railroad immigration agents, with a view to discussing ways and means of getting a larger number of real farmers upon the irrigated lands. It was shown that under all of the projects, whether built by the government or by private capital, there are great areas of fertile land to which water has been brought and which are ready for use, but upon which there is sparse settlement and small crop production. It was asserted that every successful irrigator located on such land was worth annually to the railroad from $50 to $100 and a notable amount to the state.

On the other hand, an unsuccessful farmer is a positive detriment to the community and to the railroads. There was no question but that every reasonable effort should be made to bring upon the irrigated land competent farmers who can utilize the opportunities and at the same time afford an opportunity for the man who is there and who is not making good to get into some other occupation and make room for a more able citizen.

The future of the Irrigation Congress and its use was considered and the suggestion made to consolidate it with other similar organizations, such as the Trans-Mississippi Congress, the Dry Farming Congress, etc., in order to bring into one organization the "back to the land" movement. There is a feeling that there are too many such organizations. The question also was discussed as to what really is the value of an Irrigation Congress, and whether the outcome is worthy of the large expenditure of time and money. The conclusion was reached that it is still desirable to continue these annual sessions, especially as they are bringing together agricultural investigators, engineers, and investors, and calling to public attention the opportunities for the further development of the arid lands of the West.

Granite Block Pavement is being laid to replace sheet asphalt on a portion of the street known as High Holborn, in the borough of Holborn, London, England. The portion being thus repaved comprises about a sixth of the whole street. In response to an inquiry we have been given the following particulars regarding this repaving by E. F. Spurrel, borough surveyor of Holborn:

Stone has been laid more in the nature of an experiment than for other reasons—the introduction of mechanically propelled vehicles having shown that a very durable material is necessary for main roads.

The granite blocks laid are 5 in. wide and 4 in. deep, grouted with a bituminous composition. The joint is about ⅛ in. in width. The blocks are laid on a portland cement concrete foundation 12 in. thick.

High Holborn was first paved with asphalt in the year 1885, and the surface has been renewed once since then, viz: in the year 1902.

High Holborn has a very heavy traffic—1038 vehicles per hour pass over the section in question, of which 210 are motor omnibuses weighing, when loaded, six tons.

Why Irrigating Water Should Be Measured*

By Richard R. Lyman†

A financier has said, "No man ever fails in business who keeps careful accounts." If the work of irrigation is to grow, if out of it the greatest possible good is to come, we of today must profit by the failures of yesterday. Financiers know that if the expenditures of an individual or of an institution are greater than the receipts, bankruptcy must follow.

What do the records and experiences of irrigators teach? Practically everywhere more or less land is found that is waterlogged or otherwise ruined by the excessive use of water. I ask you, irrigators who are before me today, how much water has it taken to ruin this once productive soil? I doubt if in this magnificent body of trained and experienced irrigators there is one who can answer the question. Irrigating water turned upon the desert brings forth roses rich and rare in the beginning, later the good farm becomes a poor one, and finally the poor farm becomes useless and is abandoned.

A small amount of a powerful drug may help the sick, while too much of it produces death. Irrigators have from the beginning applied a medicine to their farms in the form of water, without having any knowledge or apparent concern as to whether the dose given was one that would help the soil, or one that would do it harm. In irrigation no one seems to know the amount of the dose that helps, or the amount of the dose that destroys.

Water, in the West at least, represents money counted in untold millions. If a banker were to handle cash of one one-thousandth part this value without keeping accounts, without making records, that banker would find himself very quickly in the clutches of the law. It is as important to know and to keep a record of the amount of water that flows in a stream, to know to whom this water belongs, and to whom and in what quantities it is distributed, as it is to keep a record of the amount of gold a mine produces, the amount of cash a bank handles, to whom this wealth belongs, and how, to whom, and in what quantities it is distributed.

You ask, "Who should measure this water?" I ask, "Who should keep the records in the bank?" An expert is always required in the latter case, and an expert should be required in the other case also. The expert is always used in the bank, where the values are definite and the problem correspondingly simple, while, as a rule, nobody is employed in the other case. Where water measurements are taken and records are kept, the person employed is often wholly untrained, for this or any other technical work.

It is as important to keep a record of the flow of water in streams and in canals, and in ditches, as it is to keep the books of a bank. You who are at the head of great irrigation projects should, as I see it, be able to come to this convention with reports containing information, found in the records of your project and reading something like this: "The land irrigated under the canals of the Irrigation Project I represent is a heavy clay of great depth. For twenty years water to the amount of 1 acre-foot per acre per season has been used on this soil, but it has hardly been sufficient to produce the best results. For the same length of time 1½ acre-feet of water has been used on another section of the project with better results, while where 2 acre-feet has been used, the land has become waterlogged or otherwise ruined with water. Since there is but one crop of land—a fact so frequently referred to—is it not a shame that much of it is thus being rendered valueless? While everyone can see that too much water has been used, no one can come forward and say how much in acre-feet this excess has been.

Where are the expert irrigation engineers who have this information? If there are any such, they are few indeed. Those who own farms think generally that they are economical when they do their farming without employing engineers. As well try to build a house without an architect, conduct a school without a teacher, or a ship without a seaman, as to conduct an irrigation project of any considerable consequence without an expert irrigation engineer. The day has passed in which a man, who is too old or too stupid to be otherwise employed, can perform the duties of a watermaster. The measurement of water, and the keeping of the records of the flow of streams, if well and properly done, is work of a highly technical character. If you employ a real expert to perform this duty, and give to him, as compensation, that salary to which he is by experience and technical training fairly entitled, you will find him "the cheapest man on the job," and the money you pay him in salary will be the portion of your investment that is most wisely made. He will render you poor service, indeed, if he does not save and earn for his employer, on a project requiring the full time of a man for watermaster, many times as much in money as he receives for his service.

When I say expert, I mean an expert. Many so called expert irrigation engineers are not experts. Some years ago I was gratified to hear an official of a large irrigation project say, "We have an ex-

*From a paper read before the National Irrigation Congress.

†Professor of Civil Engineering, University of Utah.

pert in charge of our canal construction, he also directs the installation of our measuring devices and the distribution of our water. He is a remarkable engineer, he attends to the distribution of the water to the entire satisfaction of all. In great haste I sought out this wise man to find his method. "What devices," I asked, "do you use for measuring this water from one canal into another, and from the main irrigating ditch into the ditches of the individual farmers?" "Well," he replied, "sometimes I use one device, sometimes I use another, but my assistants have become so expert at judging the amount of water that flows in a canal, that the fact of the matter is they tell without any measurement."

While this man gives perfect satisfaction to those who pay him, it is a shame if it is not an actual disgrace to have this precious fluid thus carelessly and extravagantly distributed. This is why land is ruined. Every farm should be more or less experimental. Records should be kept and plottings should be made, showing how much water is used, when it was applied, and what are the results in the way of crop production. Such records would show how much water makes a good crop, how much makes a poor crop, and what quantity ruins the land.

Letters to the Editor

Long Wooden Howe Truss Bridge Spans

Sir—About 15 miles east of Eugene, Ore., there is a covered highway bridge across the MacKenzie River, consisting of two Howe truss spans, the longer of which consists of 16 panels of 15 ft., making the trusses 240 ft. long. Do you know of any longer span wooden truss?

The trusses are about 21 ft. high, and are spaced 16 ft. apart. The inclined end posts consist of two pieces 9x14 in., and the vertical members at the last panel point consist of three rods 1¼ in. in diameter. The upper chord is four 4x10-in. timbers, the lower chord four 4x12-in.

Apparently the trusses are much stronger than the floor, which is 3-in. plank laid diagonally on 3x12-in. transverse stringers, spaced 2 ft. apart, which rest directly on the lower chord.

G. E. FARNSWORTH.

Springfield, Ore.,
Sept. 16, 1912.

[Perhaps some of our readers know of longer Howe truss spans, and if so it would be of historical value to put them on record.—ED.]

Cement Gun for Coating Timber Piles

Sir—The wooden piles which were coated with cement-gun concrete, as described in your issue of Sept. 19, 1912, p. 536, were not eaten by sand fleas, as your article states, but by sea worms and insects.

Sand fleas do not attack wood in any manner, being a harmless insect living entirely in sand and feeding on sea grasses. The illustration shows work of both limnoria terebrans and teredos. The former, a small insect, works between high and low water from the outside of the pile, eating the summer wood rings one by one as they are exposed, while the teredos enter the pile through a very small hole and continually expand and lengthen themselves, at the expense of the wood, until the pile is destroyed. Teredos work from half-tide height to the bottom in all depths liable to be reached by marine structures and work more rapidly in the greater depths.

The cement gun would not be a very practicable implement at a depth of 20 ft. in water, which would quickly wash the cement from the mortar. I am at present trying some piles covered with cement mortar reinforced with poultry wire. The coating to be applied before driving the pile. The protection extending from 2 ft. below the bottom of the bay to half tide elevation in 25 ft. of water.

MORTON L. TOWER,
Asst. Engr., U. S. Engr. Dept.
Eureka, Calif., Sept. 27, 1912.

The Engineering News Rule for Retaining Walls

Sir—Your editorial on the failure of the concrete retaining wall at the Kingshighway Viaduct in St. Louis, in your issue of Sept. 26, expresses my views on the subect of retaining-wall construction, and I am pleased to see that you have brought the subject before the engineers of the country so forcibly.

I have designed and built many retaining walls, both of concrete and stone masonry, and have always insisted on having the same of proper proportions to withstand the pressure of a possible accumulation of water behind them. In doing so I have always considered that the weight of the mass of masonry should be such as to hold the wall in place, which result is not obtained when earth is used in place of the masonry, and, except under favorable conditions, I consider the reinforced-concrete wall is faulty for the reason that it lacks the necessary weight.

I agree with you that additional tie walls might have prevented this failure, but not as well as a heavier wall or outside buttresses would have done.

JAMES RITCHIE.

Electric Bldg., Cleveland, Ohio.,
Sept. 28, 1912.

Earth Pressures against Retaining Walls

SIR: I have read with interest your editorial on page 593 of the Sept. 26 issue on "The Bursting Pressure of an Earth Fill." It is encouraging to find an editor of a thoroughly scientific paper who is still willing to throw aside both science and mathematics and get down to actual cases. In walking along the streets of almost any large city in the country, if one casts his eye critically over the retaining walls in front of the residences as he passes, he will observe that about 19 out of 20 are out of their original alignment and indicate that they are not heavy enough to withstand the pressure they were built for. This is partly due to custom and partly due to ignorance, as you suggest. At the same time there appears to be an impression among engineers who are supposed to look further than mere custom that an earth bank has some magical power to stick to itself and allow only part of its weight to come against the retaining wall. There are numerous mathematical solutions to sustain their view, and numerous practical demonstrations among walls actually in use to disprove it.

I was at one time engaged by one of the largest engineering and contracting firms in the country to design a wooden coffer-dam or bulkhead to surround an excavation for a pier which was to be sunk in sand thoroughly saturated with water. After looking the situation over it occurred to me that this sand in a quaking condition was practically a liquid, and would act as such against the bulkhead; therefore I designed the bulkhead to take the entire hydrostatic pressure of a liquid weighing something over 100 lb. per cu.ft.—the actual weight of the wet sand. When the chief engineer saw my design he was highly amused, explaining to me as he would to any young man fresh from an engineering school, that the whole pressure of earth never, as a matter of fact, exerted itself against the bulkhead, and he pulled down some

heavy-weight engineering authorities to prove it. The bulkhead was accordingly designed to take part only of the fluid pressure. When the excavation was competed, the first pile driven in to support the concrete pier jarred the earth just enough to bring about the absolutely fluid condition which I had figured on; and the bulkhead began to collapse, fortunately slowly, the 12x12 struts cutting entirely through the 12x12 girts like so much cheese. In great haste more lumber was ordered and more struts were placed, so that when the structure was completed it exactly conformed to the total-fluid-pressure ideas I had started with.

A somewhat similar accident to the one which occurred in St. Louis and which inspired your editorial, happened here in Kansas City to a concrete wall built to serve the double purpose of supporting one side of the "Star" building and also of forming the basement or press room When the excavation had been completed and the wall was in place a heavy rain occurred. The water had free access to that part of the soft clayey ground near the wall. The next morning the wall appeared, to the astonishment of all parties concerned, pushed clear out of its original location. A few minutes' work with a pencil, however, would have been sufficient to forestall any astonishment, because it could have been demonstrated easily that the wall was not figured to take the entire pressure of semi-fluid clay against it, yet it was almost inevitable that such a condition would at some time or other occur; and when it did, there was nothing but the prayers of the architect to keep the wall from overturning or moving out.

These are but a very few instances out of several which lead me to suspect that your empirical rule for retaining walls would be better if, instead of calling for a calculation based on water pressure of two-thirds the height of the wall, it were based on water pressure of the entire height of the wall; and, in case of extremely slippery material such as quicksand or soft and wet clay, to use the entire weight of the wet earth instead of merely the weight of water. This would take it entirely out of the class of mathematical guesswork and enable the engineer, contractor or owner to say definitely he knew that he was on the safe side where he ought to be.

Yours truly,

BENJAMIN BROOKS.

4241 Holmes St., Kansas City, Mo.
Oct 1, 1912.

[It may be worth while to emphasize that what we proposed as "the ENGINEERING NEWS rule for earth pressures" was to assume the pressure to be *at least* as great as that of water of two-thirds the depth. There are cases unquestionably where the actual pressure exerted by soft clay or quicksand against a wall is greater than that of an equal bulk of water.—ED.]

Will Mixing Concrete Too Wet Cause Its Eventual Failure?

Sir—A great deal is heard of the gradual destruction of concrete structures, some assigning electrolysis as a reason and others claiming the trouble is due to lack of uniformity in grinding cement. Too many structures are now standing for us to believe that coarseness of cement is a prime cause for the numerous failures in appearance. Not enough is known about electrolysis for us to think this accountable for many, if any, failures. The writer is convinced that the use of too much water is liable to make concrete unsound. He knows from experience that the use of an excessive amount of water with limestone or any sedimentary stone will make a concrete that never gets as hard as it should and which will go to pieces in a few years, beginning with the surface. The trouble does not seem to occur when a granite or trap-rock aggregate is used, though perhaps it may in some places. While he prefers the "wet" mix to an extremely dry mix, the amount of water should be such that the concrete must be assisted from the wheelbarrow, cart or bucket. That is, the concrete should be sticky and not of a consistency that it will flow too freely. When much free water stands on the surface in the barrows it is unfit to use in important work.

The writer has been interested in watching the development of the numerous spouting devices now on the market and is amazed to see the number employed and to see how rapidly this method for placing concrete is coming into use. This seems to him to be the proper time to make a prediction. He believes that in the future we will hear more about the "decay of concrete," as one inspired newspaper writer labelled the discussion of unsound concrete. In three or four years, and certainly in five years, a number of structures going up today will begin to show surface cracks, which upon examination will be found to extend quite a distance into the mass.

A casual examination only of some of the plants now pouring concrete into important structures will satisfy any competent concrete man that in the majority of cases a dangerous quantity of water is used. The laboratories should begin at once to make tests of concrete mixed with varying amounts of water, to obtain the coefficient of expansion and contraction, and behavior upon exposure similar to that of the many structures now causing alarm. Spouting devices cannot give good service unless a large amount of water is used in mixing, and to keep the concrete flowing it is found necessary to add more water. What becomes of it? An excessive amount of water has a bad effect on the finely ground particles of cement and the excess water certainly leaves concrete porous when it leaches out. A medium wet, tamped concrete is more water tight and dense than a very wet, poured mixture.

ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Ill.,
Oct. 5, 1912.

Notes and Queries

Our attention has just been called to an error occurring on page 223 of our issue of Aug. 1, in which was stated the average cost of the proposed reservoir system for flood control on the Allegheny and Monongahela Rivers per 1000 cu.ft. of water storage capacity. The average total cost was there stated to be $1 per 1000 cu.ft. of water stored. The correct figure should be $0.364 per 1000 cu.ft. of water stored. The total storage capacity provided is 59,481 million cu.ft. of water, for which the total estimated cost is $21,672,000.

In the article "Development of Electric Circuit Breakers," in our issue of Oct. 3, the beginning of paragraph one in column three, p. 627, should read "air circuit breakers" instead of "oil circuit breakers" as printed.

A correspondent asks for knowledge of instances of reinforced-concrete structures, particularly exposed work like docks, piers, etc., which have been struck by lightning. We would be pleased to describe any such cases, giving particular attention to the effects of such strokes.

A Railway and Highway Drawbridge with single deck is to be built across the River Trent at Keadby (Lincolnshire), England, by the Great Central Ry. The movable span will be of the Scherzer rolling-lift bascule type, with a single-leaf span of 160 ft. and width of nearly 60 ft., and will be one of the largest bascule bridges in the world. There will be two fixed shore spans and a shore span formed by the track girders for the bascule span. The total length of the steel work will be about 500 ft. Each span will have three trusses, spaced 29 ft. centers for the railway side and 24 ft. for the roadway side.

The bridge will be operated by electricity generated in a power station built for the purpose. The motors and gearing will be placed on the rear end of the marble leaf, the main pinions engaging with racks on independent stationary supports outside of the trusses. This arrangement is said to require less machinery and less power than when the machinery is mounted on fixed supports and the pinions engage operating racks attached to the movable portion. The substructure will consist of masonry piers founded on steel caissons sunk to a depth of 50 ft. below low water. The bridge was designed by the Scherzer Rolling-Lift Bridge Co., of Chicago, and the contract for its construction has been awarded to Sir William Arrol & Co., of Glasgow (Scotland). J. B. Ball is Chief Engineer of the Great Central Ry.

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Contents

Page

*The Largest Side-Wheel Passenger Steamers on the Great Lakes..... 695
A Great Reservoir of Oil Fuel; David White 696
The Army of God-Knows-Where; Alfred Damon Runyon..... 698
*Costs of Leveling Ground with an Electric Drag Scraper; James C. Bennett 699
Sanitation of Water-Supplies; William T. Sedgwick; A. C. Houston; George W. Fuller; Samuel Rideal; M. Diennert; George A. Johnson; G. Gaertner; Rudolph Hering..... 700
*Separately Molded Concrete Guard Rails for Roads..... 705
*The North Side Point Bridge over the Allegheny River at Pittsburgh 706
*Types of Defective Rails and Some Methods Used in Detecting Them; Robert Job 710
The Relation of the Contractor to the Public Official; C. A. Crane.... 712
*Camp Sanitation 714
Future Uses of Solar Energy..... 716
Railway Locomotives as Fire Engines on the Pennsylvania R.R.... 717
Reaching the High Places or Booster Pumps; H. E. Cole..... 718
*Dynamiting an Unsatisfactory Concrete Arch 720
The Twentieth Annual Irrigation Congress Held at Salt Lake City (Contributed) 721
Why Irrigating Water Should be Measured; Richard R. Lyman..... 722
LETTERS TO THE EDITOR..... 723
Long Wooden Howe Truss Bridge Spans; G. E. Farnsworth—Cement Gun for Coating Timber Piles; Morton L. Tower—The Engineering News Rule for Retaining Walls; James Ritchie—Earth Pressures against Retaining Walls; Benjamin Brooks—Will Mixing Concrete Too Wet Cause Its Eventual Failure?; Ernest McCullough—Notes and Queries.
EDITORIAL 725
A Question in Sanitation—Warnings against Frozen Concrete—Will There Be a Car Shortage?
Future Sources of Oil Fuel Supply 726
ENGINEERING NEWS OF THE WEEK 732
PERSONALS 733
ENGINEERING SOCIETIES 734
ENGINEERING LITERATURE..... 735

*Illustrated.

Engineering News

An interesting question in sanitation is raised, quite unintentionally, in a recent bulletin of the Extension Division of the University of Wisconsin. The suggestion was made by P. V. Collins, editor of the *Northwestern Agriculturist*, that alongside the farmer's coöperative creamery there be placed a farmer's coöperative laundry, the soiled clothes and cream to be carried on the same wagon to the laundry and to the creamery, respectively. Presumably some means might be devised for avoiding infection of the cream by the soiled clothes, but it might not be an easy matter to see that the necessary precautions were always taken. Anyway, the sanitary aspects of the proposition should not be overlooked. Where the cream is efficiently pasteurized the danger would be practically eliminated.

In the past few years several reinforced-concrete concerns have made it a practice about the beginning of the Fall season to issue to their clients a bulletin or placard calling attention to the dangers of frozen concrete. The practice is highly commendable and if concrete workers would take the precautions which these companies recommend, a number of the failures of the late Fall and Winter would be avoided.

The next three months are the crucial ones. When the thermometer stays below the freezing point, it is only the most ignorant of constructors who does not take some precaution to keep his concrete from freezing; but in the late Fall when the days are warm and the nights cold, with the thermometer dropping 20° to 40°, many otherwise competent contractors often forget that besides the dangers of frozen concrete, there is the fact that concrete when near the freezing temperature sets very slowly. It was not so long ago that much concrete work was shut down when the cold weather set in, but so severe measures are not now necessary. Engineering literature contains plenty of information as to means for laying concrete safely in freezing weather, and a realization of the danger is all that the wise man needs to apply this information to his practice. We are by no means convinced that all the failures attributed to frozen concrete are due to that cause, for it, together with the premature removal of forms, is the stock explanation upon which investigators of concrete failures can always fall back. But that it is a real danger no one can doubt, and all efforts to guard against it are commendable.

Will There Be a Car Shortage?

A good deal is being said in the public prints as to the prospect of a serious car famine occurring this fall and winter similar to that which occurred during the business boom of 1907. It is pretty well known that ever since the business reaction which followed that boom the railways have had practically all the time a surplus of idle cars of greater or less amount. It is very natural to conclude, therefore, that the volume of railway traffic reached its maximum in 1907 and that if a similar volume were reached during the present year, a similar condition of car famine would occur. The fact is, however, that for some two years past the volume of railway traffic, taking the country as a whole, has been far in excess of its volume in even the most active days of 1907. The official figures for the year ending June 30, 1911, are not yet at hand, but for the year earlier, ending June 30, 1910, the total ton mileage of freight traffic was 255,000 million ton-miles, which may be compared with 236,600 million ton-miles in the year ending June 30, 1907. It is noteworthy that this enormous freight traffic has been handled not only with no car famine, but with a surplus of idle cars most of the time.

There is every prospect that the great crops of the present year, the active business in iron and steel production, and in manufacturing in general will result in the greatest freight-traffic movement by rail during the coming twelve months that has ever been recorded; but this need not cause a car famine if reason prevails among railway officers and among shippers. The serious car shortage of 1907 was due more to the blockade of cars in overcrowded terminals, some of them ill-supplied with motive power, than it was to the actual volume of traffic to be moved. Other contributing causes equally important were the grabbing and holding of cars by both railways and shippers.

It is entirely natural, of course, for a shipper, if he thinks he will have difficulty in obtaining cars, to ask for more than he needs, and to keep a supply of empty cars awaiting loading if he can do so. A railway company likewise is tempted to divert foreign cars to its own use rather than to send them homeward. It is, therefore, in the interest of the public and of shippers in general, that there shall be a strict enforcement of car demurrage payments for the delay of cars in loading and unloading beyond the specified time. It is almost equally im-

portant that the per diem rate charged by the railways to each other for the use of foreign cars should be raised to an amount which will at least put some reasonable penalty on the diversion of cars from their owners. The enforcement of such measures will do more to prevent a car famine than the addition of many thousands of new cars to the available rolling-stock equipment. The addition of only a few miles a month to the average travel of all freight cars means a far larger addition to the available stock of cars for shippers' use than would a veritable boom in new car construction.

Future Sources of Oil Fuel Supply

One of the problems of conservation which is of great practical interest to engineers is the problem of the future supply of oil fuel. It is pretty well known that the soft-coal fields of America are so enormous in extent that their exhaustion can hardly take place for several centuries. Of course, it is true also that many of the most accessible and most easily mined coal seams have already been worked out and we are now obliged to go to a greater depth and to work poorer deposits. There is certain to be, therefore, a steady increase in the cost, and deterioration in the quality of the soft-coal supply as the years go on.

With oil fuel, however, the exhaustion of our resources has been supposed to be comparatively near at hand. Up to a recent date, geologists were generally of the opinion that the oil-fuel resources of the world were comparatively limited in extent. Only a very few years ago, the Eastern Appalachian oil fields, of which western Pennsylvania is the center, and the Russian oil field, centering around Baku, were practically the sole sources of the world's petroleum supply.

In recent years, however, the situation has been entirely changed by the discovery of a series of new oil fields of remarkable richness. We need only mention, as examples, the discoveries in Texas, in Mexico, in California, in Oklahoma, in Kansas, in Louisiana, and in Illinois, and in the old world the development of vast deposits in Borneo, in Asia Minor and many other places. These discoveries of petroleum deposits have been coincident with an enormous increase in the uses of liquid fuel, and particularly in what we may designate as the high-grade uses.

There has been no greater revolution in mechanical engineering for a century than the results which have grown out of the discovery that by burning fuel inside a cylinder and using its heat energy directly to generate power we can obtain three, four, or five times as much power from a given amount of heat generated as we can by burning the same fuel under a steam boiler and using the steam to produce power.

During the past twenty years the automobile industry of the world has grown from an inventor's dream to an industry representing an investment of probably half a billion dollars at least. The industry is still expanding at a phenomenal rate and it is not hard to foresee the time when mechanical traction will almost wholly displace animal traction, not only on city streets and common roads, but in the work of the farm.

This entire industry, however, with all its present successes and future possibilities is based upon a supply of gasoline adequate to its demand. The crude petroleum from many fields, however, yields only a small percentage of gasoline on distillation and the automobile industry and others dependent upon the gasoline supply have to rely upon the yield from the comparatively few fields which produce an oil containing a considerable percentage of volatile matter.

It is indeed little short of amazing that the gasoline supply of the world has thus far kept pace with the rapid expansion of the automobile industry and its near relative, the motor-boat industry. It is extremely probable that the expansion of the gasoline supply cannot be expected to keep pace with the future developments certain to occur in the use of gasoline engines.

The situation will probably be met, however, by a radical change in the construction of this class of motors by which they will be enabled to use a heavier grade of oil in their cylinders. In fact a considerable number of stationary and portable engines are already on the market which burn kerosene in the cylinders with a fair degree of success. We may even look forward to a still more radical change by which many classes of motors may even be able to use such heavy oils as are already used successfully in the Diesel type of engine and its near relatives.

These changes, however, can only serve to make the total supply of liquid fuel go farther. Valuable and important though they are, they cannot add at all to the available stores of liquid fuel in the earth, and the question of great importance is, "How long will the total output of the world's petroleum wells be equal to the demand upon them?"

The phenomenal development of new oil fields of marvelous richness during the past decade has seemed to many to settle the question of future oil supply. It seems to be thought in many quarters that as fast as one new oil field is exhausted another will be found to keep up the production. Dr. Rudolf Diesel, the inventor of the Diesel engine, in his address before the American Society of Mechanical Engineers last April, declared that recent geological researches indicated that there is probably as much liquid fuel on the globe as there is of coal. We believe, however, that this represents an extreme view and one which conservative geologists will hardly support. If the developments in California, Texas, Illinois, and the East Indies during the past few years have indicated that the world's wealth of available liquid fuel is much greater than seemed probable ten years ago, it is true on the other hand that the enormous increase in consumption and demand is tapping the oil deposits at a rate which would have seemed impossible 20 years ago.

A short life and a merry one is the history of the present-day oil fields. In order that production may keep pace with consumption we are relying on the *chance* that new pools and new fields will continually be discovered and developed. It is, therefore, no merely academic problem to inquire what the world can do in the near future to obtain the liquid fuel which it needs, when the time comes, as sooner or later it must come, when the petroleum wells fail to yield sufficient supply.

Notwithstanding all the influence of monopoly in this field, it is nevertheless true that the current prices of crude petroleum and to a considerable extent of its products are more or less closely governed by the relation between supply and demand. Increased prices for gasoline and fuel oil have in some quarters at least been already put in force during the past year. It is well nigh certain that such higher prices may be expected to rule in the future. Such higher prices will, of course, have the effect of limiting to a certain extent the consumption. The use of oil fuel for raising steam, for example, will in most sections be abandoned and coal will be again introduced whenever a small increase is made in the price of fuel oil.

Such changes are undoubtedly in the interest of sound conservation; but when we come to the uses of gasoline and other volatile distillates of petroleum in the arts or the use of liquid fuel inside the cylinders of oil and gasoline engines, no such substitution is possible, or at least probable. Therefore, if the automobile is to be a permanent machine; if the horse is to be banished from streets and roads, and if the economical internal-combustion engine is to replace the wasteful steam engine on boats and ships, then a continued and certain supply of liquid fuel is a necessity.

To many engineers, probably, it will be news that the petroleum wells of the world are not the only source of liquid fuel. One other source, already of great industrial importance abroad, was described by Dr. Diesel in the lecture above referred to. The tar oils produced by the distillation of soft coal, especially of low-grade brown coal or lignite, of which

enormous deposits exist in the United States and elsewhere in the world, have already been proved to be available as fuel in the Diesel engine; and it has been shown that they can yield, by proper treatment, a variety of products similar to those obtained from petroleum.

There exists, however, a possible source of future oil-fuel production of far greater importance than the oils obtained from the distillation of coal. We refer to the production of oil by the distillation of bituminous shale. While the possibilities in this direction have long been known to a greater or less extent by geologists and scientists, they were first pointed out to the general public, so far as we are aware, by the late Prof. N. S. Shaler, of Harvard University, in his remarkable little book, "Man and the Earth," published in 1905. It was this book which first called general public attention to the enormous waste which is going on in the consumption of our natural resources and the need for their intelligent conservation lest the whole world be rapidly reduced to poverty. Prof. Shaler in this book discussed in a most interesting way the enormous inroads which the past century and especially the past few years have made upon the stored-up natural resources of the world. The book is one which every engineer, at least, ought to read, for it may well be called the original primer of conservation.

In the chapter devoted to the world's fuel resources, Prof. Shaler set forth the origin of the world's petroleum deposits and explained the reasons why the great bulk of these deposits have long ago been dissipated. After predicting that the world's supply of petroleum from wells sunk in the earth's crust, making all allowances for the production from new fields, would probably not outlast the present century, Prof. Shaler discussed the possibilities from other sources of liquid fuel in a striking passage which we quote as follows:

> While the native petroleum of the world can be no more than a temporary source of energy, oil of like quality can be produced in vastly larger amounts from certain carbonaceous shales which plentifully occur in various parts of the world.
>
> One of these formations, perhaps the most extensive, is that of the Ohio Valley and adjacent districts in the East and North. Here we have a set of beds averaging more than a hundred feet in thickness which, over wide areas, will yield to distillation probably about one-tenth of its mass in oil, paraffin and related substances.
>
> From this deposit, but one of the many that are found in various parts of the world, we may look for a store of energy which may be drawn upon long after the beds of coal have been consumed.
>
> This oil will be won at much greater cost than oil obtained from wells in the fluid state; but the byproducts of the distillation to which the rock is subjected will probably be as valuable as those afforded by the natural oil.

The present writer has computed that the oil which may possibly be had from the Ohio shale above mentioned will in volume much exceed the amount of water contained in Lake Superior. This estimate cannot pretend to accuracy; but it may serve to indicate the amplitude of this source of material.

The practical importance of this statement of Prof. Shaler's will be readily apparent from what we have said above. It needs no very far outlook into the future to foresee the possibility and even the probability that in some sections these carbonaceous shales may soon be resorted to as a supplementary source of oil fuel supply. In view of the importance of the matter, we have deemed it worth while to obtain from the U. S. Geological Survey a statement as to the position held by geologists at present concerning this prediction of Prof. Shaler's. Elsewhere in this issue we print a statement on this subject prepared especially for ENGINEERING NEWS by Dr. David White, of the Survey, which has been obtained for us through the courtesy of Dr. J. A. Holmes, Chief of the Bureau of Mines.

It will be noted by the reader of Dr. White's article that a calculation is made that the distillation of bituminous shale to obtain fuel oil may become commercially profitable when kerosene reaches a price of 20c. per gal. and gasoline of 40c. per gal. These prices, however, are merely rough approximations. It is quite within the possibility that there may be deposits of this shale which would yield so large a content of liquid fuel, together, perhaps, with other valuable byproducts that we may see the industry begin to be established at no very distant day.

It may be noted that a most favorable feature in connection with the development of such an industry would be the effect of modern processes of excavating and handling material in bulk.

While coal occurs in thin seams and must be won by a special process of mining involving the supporting of the roof by pillars of coal left in the mine and much expense in timbering, etc., bituminous shale occurs in beds often 25 to 100 ft. in thickness or even more. Of course, it remains to be proved that the whole thickness of such beds is rich enough in fuel oil to be profitable to work; but the possibility at least is there. If such deposits can be found and their value proven, it will be possible to excavate them and prepare them for distillation at an extremely low cost per ton by the methods now commonly employed in quarrying rock for road building, cement making, concrete construction, etc.

It is of interest to know that the possibilities in this direction are now being investigated by the U. S. Geological Survey. It will be indeed a most comforting assurance to those who are relying on the continuance and future development of the automobile industry and on the numerous other industries dependent upon a continued supply of liquid fuel, to know that as a final resource there are vast quantities of possible stores of liquid fuel apart from the yield of oil wells.

The Prime Essential in City Planning

One reason, and a strong one, why so few of the many recent "city plans" have been carried out is that the generality of people think city planning is merely an ultra-esthetic fad. The fallacy of this notion is well shown by the following paragraphs from a report entitled "A Plan of the City of Hartford," submitted to the Commission on the City Plan of Hartford, Conn., by Carrére & Hastings, of New York City.

> It will be noticed that throughout the report not a word has been mentioned about the beauty of the city and that particular stress has been laid throughout on organic and practical considerations. It is not generally understood that in a problem of this kind beauty does not consist in ornamentation, as is generally supposed; that the beauty of a bridge, for instance, is not the result of a handsome balustrade or a few lamp-posts or some ornament, but that it is fundamental and is a part of the conception and depends on its being a truthful expression of a practical purpose, well conceived and developed in good proportions, harmoniously, and expressed in terms of beauty in so far as form and detail are concerned; and that no mere surface ornamentation can make a bridge, a building, or any object beautiful that does not serve its purpose, that is not conceived in truthfulness and developed in its proper relation to its function and to its surroundings.
>
> It follows, therefore, that if the organism of the plan is correctly conceived and laid out, if all of the practical conditions are met truthfully and completely, if the lines of traffic are the shortest in any direction and ample for all purposes, if the relation of width to length and purpose of the streets, avenues, and parkways is well planned, the matter of developing the practical features of a city on this groundwork becomes a mere detail. Even if unattractive buildings and other improvements should be erected, either in part or in whole, they can be removed and replaced and in time the city can grow complete in its beauty, which is bound to happen.

Put still more briefly, the basic principle of city planning is the adaptation of form to function. This was brought out forcibly many years ago by the elder Olmsted, who instanced the fast sailing commercial ship of bygone days as an example of artistic form developed solely for utilitarian reasons.

Unfortunately the present on-the-whole sane city planning movement was preceded by so much well meant but ill-considered talk about the city beautiful that it will take many years to convince the public that city planning is intensely utilitarian, having for its main object the working out of a rational ground plan for the every-day needs of those who must move about and live in the cities.

Annual Convention of the American Electric Railway Association

The 31st annual convention of the American Electric Railway Association (that is, the 31st meeting dating from the organization of the old American Street Railway Association), was held Oct. 7 to 11 at Chicago, and included the annual meetings of the four affiliated societies: the American Electric Railway Engineering, Accountants, Transportation & Traffic, and Claim Agents Associations. This last has now changed its name to the Claims Association. In connection with the convention there was the usual large and comprehensive exhibit of equipment, materials and supplies for electric railways, arranged by the American Electric Railway Manufacturers Association. The attendance was large, and the total registration of members, guests and the representatives of manufacturers and supply firms was about 4400. The meetings and exhibits were at the stock-yards, the former being held in the rooms of the Saddle and Sirloin Club, and the latter being displayed mainly in the new Live-Stock Pavilion or exhibition hall.* The electric locomotives, cars, trucks and other large exhibits were arranged on tracks in an open space between the hall and the club house.

The four affiliated societies held their meetings on the afternoon of the first day and the mornings of the other four days. The main association (generally known as the "American" association) held its meetings on three afternoons. In this way, members could attend the main and sectional meetings. The latter included simultaneous meetings of the different associations, but joint meetings of some of these were held to consider subjects of mutual interest or handled by joint committees. Thus the Engineering and Transportation associations held joint meetings to discuss reports on block signals and train operation, and the Engineering and Accountants associations held a joint meeting to discuss reports on accounting and valuation.

OFFICERS—The presidents and secretaries of the several associations, as elected for the year 1912-13 are as follows:

American Electric Railway Association; George H. Harries, President of the Arkansas Valley Ry., Light & Power Co., Louisville, Ky.

The Secretary of the American Association is H. C. Donecker, New York; he is Secretary also of the Transportation and the Engineering associations.

American Electric Railway Engineering Association; Martin Schreiber, Engineer of Maintenance-of-Way of the Public Service Ry. Co., Newark, N. J. As noted, Mr. Donecker was elected secretary after the resignation of Norman Litchfield, who has been secretary for years, but finds the amount of work too great to be handled without interfering with his regular business. A gold watch was presented to Mr. Litchfield by the members of the Engineering Association.

American Electric Railway Transportation and Traffic Association; Dana Stevens, Vice-President and General Manager of the Cincinnati Traction Co., Cincinnati, Ohio.

American Electric Railway Accountants Association; J. H. Neal, Auditor of the Boston Elevated Ry., Boston, Mass.; Secretary, M. R. Boylan, Auditor of the Public Service Ry. Co., Newark, N. J.

American Electric Railway Claims Association; C. A. Avant, Claims Attorney of the Birmingham Ry., Light & Power Co., Birmingham, Ala.; Secretary, B. B. Davis, Claim Adjuster of the Columbus Ry. & Light Co., Columbus, Ohio.

THE AMERICAN ASSOCIATION

The first meeting of the American Electric Railway Association, which is the main or parent association, was opened about 2:45, Oct. 8, with Vice-President Harries in the chair, owing to the absence of President McCarter on account of illness. Mr. McCarter's presidential address (read by Mr. Allen, Vice-President) pointed out that publicity rather than secrecy is the order of the day, and that in recognition of this fact the main association has this year (for the first time) abandoned its executive sessions and thrown open all meetings. He referred also to the very extended trip made by a group of officers of the association in order to arouse interest in the association and its work, and to discuss problems and public questions with local railway officers, business men and public officials. An address of welcome was given by George B. Caldwell, President of the Continental & Commercial Trust & Savings Bank. A resolution was passed extending the congratulations of the association to John M. Roach (Chicago), who has completed 40 years of service in street-railway work. An invitation to meet at San Francisco in 1915 was given by a representative of the Panama Exhibition Co. The Secretary (H. C. Donecker) read the report of the Executive Committee, and also his report as Secretary and Treasurer. This latter showed (for Sept. 30, 1912) 393 company members and 2557 individual members. The receipts for the year were $68,589 (including the 1911 balance of $17,927), and the expenditures $50,955, leaving a balance of $17,634.

Papers read at the three sessions held by this association included the following: "Water Power Development and its Relation to Public Utilities," by James E. Hewes; "A Policy of Publicity," by Arthur Warren; "Arbitration in Australia," by J. S. Badger (Brisbane, Queensland); "The Milwaukee Fare Case," by R. B. Stearns; "Electric Railway Securities," M. W. Gaines; and "Automatic Regulation of Rates," by Oscar T. Crosby. Among the committee reports presented were those on welfare of employees, education of shop apprentices, insurance of property, relations with local associations, taxation, determining the proper basis for rates and fares, and compensation for carrying the mails. A resolution was adopted expressing the desirability of coöperation between various associations in regard to reducing the litigation and disputes over alleged damages due to electrolysis.

RAILS AND TRACK

The Committee on Way (Engineering Association) submitted designs for 7-in. and 9-in. grooved girder rails, including guard-groove sections for curves. These were not adopted as standards, however, but were referred back to the committee, as were the proposed sections for splice bars for the same rails. Objections were made to the form of the guard section, and changes in this might affect the form of the groove and rail head. Another objectionable feature, not noted in the discussion, however, was the extreme beveling of the outer side of the rail head, the lower edge of the bevel being $\frac{1}{16}$ in. below and $\frac{7}{8}$ in. beyond the running surface of the head. This feature is supposed to provide for irregularities in paving, but it is not used in T-girder rails and there seems to be no good reason why it should be used in grooved-girder rails. The outer or guard side of the groove, as proposed, was very thin and wide, and thus liable to deflect under traffic, while its top was $\frac{3}{4}$ in. below the top of the rail head, making a decided step in the paving. In the curve rail, this guard was much shorter and heavier, and carried $\frac{3}{4}$ in. above the rail head.

The committee has made an investigation as to the use of T-rails in paved streets, and presented a tabulation of the replies from 72 cities and 74 companies. Most of the latter report a comparatively small mileage laid with such rails, although the Milwaukee company reports all of its 144 miles so laid. In a few cities, the T-rail is not permitted. The report states that no trouble has been experienced where the high T-rail or T-girder rail is used, and that city officials who were opposed to the T-rail had experienced trouble with ordinary rails (of steam-railway section), as it was alleged the pavement could not be held in position on account of the depth of the rail. The committee submitted specifications for openhearth girder and high T-rails,

*This is a steel-frame structure with two-hinged arch trusses, and was built to accommodate the annual live-stock exhibition. Its construction was described and illustrated in Engineering News, June 28, 1906.

as revised in consultation with the American Society of Testing Materials. These were adopted (and have already been adopted by the society named). It presented also some notes on the use of alloy steels. We shall publish later some particulars as to the report and discussion on grooved rails, and it is of interest to note also that the Committee on Equipment is to investigate the relations between wheels and rails.

Block Signals for Electric Railways

The report of this joint committee of the Engineering Association and the Transportation and Traffic Association presented a digest as to state control of block signaling on electric railways, from which it appears that this exists in California, Indiana, Massachusetts, Minnesota, New York and Wisconsin, although in Indiana only has the power been exercised actively. A bill has been presented at each session of Congress since 1903 giving similar authority to the Interstate Commerce Commission, but has not been passed. In the discussion, Mr. Henry (Ind. & Cin. Traction Co.) spoke of the very active and fair manner in which the compulsory requirements for block signaling have been administered by the Indiana Railway Commission, which has its own signal engineer. He also described the Simmen dispatcher-operated signal system in use on his road (Engineering News, Aug. 29, 1912). He considers this superior to the continuous track-circuit automatic block-signal systems in that it gives the head office a continual and permanent autographic record of the positions and movements of every car or train on the road.

There was a sharp discussion on the question whether the system of automatic block signals with continuous track-circuit is so superior to others that it should be definitely recommended. The sense and wording of the recommendation were attacked, and after some amendments had been proposed, the recommendation was referred back to the committee. The report also recommended three-position semaphore signals, making no mention of lamp signals, but this was modified to provide that "where semaphore signals are used" they should be of the three-position type, giving indications in the upper left-hand quadrant. The meeting adopted the series of indications proposed for three-position and two-position signals (for both semaphore and light signals) and adopted the recommendation that all signaling should include the use of the three fundamental indications: stop, proceed-with-caution, proceed.

Buildings and Structures

The report of this committee of the Engineering Association made no specific recommendations, but submitted two matters of interest: 1, general specifications and form of contract for the construction of railway buildings; 2, a paper on waiting rooms and shelters for electric railways. We shall publish an abstract of this later. In the discussion, the question of the relative merits of concrete and slow-burning mill-type construction was considered, and one member stated that a six-story car-house and office building of mill-construction was burned down in 20 min. Even concrete car-houses require sprinkler equipment owing to the inflammable material stored in the building, but the equipment need not be so extensive as when it is required also to guard against a burning roof. It appears, however, that insurance companies in some cases make no difference in rates on the two classes of buildings, which tends to check the use of fireproof construction. Mr. Schreiber (Newark, N. J.) remarked that for short spans (covering two tracks) a concrete roof would cost less than one of non-fireproof construction, but that for longer spans the former would cost considerably more than the latter.

Overhead Work

The report of the Committee on Power Distribution (Engineering Association) dealt with a variety of subjects and presented several specifications for overhead work and material. The specifications included the construction of crossings of trolley wires over steam railways and of foreign wires over electric railway wires; also such materials as conductor cables, tile conduit, cross-arms and braces, and the galvanizing of iron and steel. The committee submitted also revised tables for copper wire and cable. There was very little discussion, and that related mainly to (1) the joint use of poles and (2) the use of trolley guards. As to the former, Mr. Roberts (No. Ohio Traction & Light Co.) thought that the main point was to insist that the work should be made safe for the linemen to work, and for that reason telephone and transmission wires should be not less than 15 in. from the center of the pole, in order to give ample clearance. This view was disputed by others, but as a special committee of the American Association has been appointed to deal with this subject, no action was taken.

Trolley Guards

In regard to the use of guards to prevent trolleys from leaving the wires at steam-railway crossings, the report of the above Committee on Power Distribution stated that the additional hazard introduced by these guards is not generally warranted by the benefit derived, and that the dangers at grade crossings are best minimized by proper construction of the overhead work and proper maintenance of the track. Consequently, the committee recommended as follows: "Trolley guards should not be used, except possibly in unusual cases due to complicated alignment of the crossing track."

The discussion was sharp and largely opposed to the committee's view, it being pointed out by several speakers that usually it is a difficult matter to keep the tracks in good line or surface, especially as the steam railways rarely coöperate with the electric lines in this respect. These being the actual conditions, trolley guards minimize the chances of accident and are needed more than the report would indicate. In addition to this, the increased height of the wire at crossings, to give the required 22 ft. clearance, causes greater liability of the trolley jumping. Mr. Page (Western N. Y. & Penn. Traction Co.) thought that steam railways approved of these guards, and instanced reports to this effect by special committees of the B. & O. R.R. and Michigan Central R.R. Cases of the trolley leaving the wire may be rare, yet when they do occur they cause a very dangerous condition, so that the guard is a valuable preventive of such a condition.

Mr. Thompson (Ohio Electric Ry.) said that his road had been requested by some steam railways to install these guards, but had declined to do this on the ground that the hazard introduced was greater than the benefit derived. However, Mr. Roberts (No. Ohio Traction & Light Co.) explained that the Ohio Railway Commission is now making the installation of trolley guards compulsory. Other speakers referred to the satisfactory use of guards (including one 300 ft. long over a group of tracks), and it was pointed out that in case of an accident damage suit, the fact that a guard was not installed would have some weight with the jury.

A motion was made that the committee's recommendation against the use of guards should not be approved, and when several non-eligible votes had been eliminated by a roll-call the result was a tie: 9 to 9. Mr. Litchfield (Interboro Rapid Transit Co.) suggested that the discussion and vote showed a very even balance of opinion on both sides, and it was too important a matter to be disposed of arbitrarily by the casting vote of the chairman. He moved that the matter should be referred back to the committee for further consideration, and this motion was carried.

Detecting Faulty High-tension Cables

The report of the Engineering association's Committee on Power Generation included a paper on methods of selecting faulty high-tension cables at the power house. There was no discussion. The general conclusions were as follows:

1. Present methods of selecting faulty high-tension cables are inadequate.
2. Ground detectors do not satisfactorily select or indicate.
3. The Torchio-Varley system (based

on the principle of relative phase insulation resistance to ground) and several other systems and schemes meet at the best only detail local conditions.

4. Relays never have handled all conditions satisfactorily, but the prospect of their doing so is considerably more promising than ever before.

5. Modifications of the Mertz-Price system (requiring pilot wires) give the desired results but the cost is too high for general use.

6. Stott's suggestion (using overload relays) gives a new practical quick method at moderate cost and is applicable to practically all conditions of operation.

7. In many cases valuable time is now being unnecessarily wasted due to the fact that there are no satisfactory methods in use.

Chemical Laboratories and Tests

The report of the Engineering Association's Committee on Power Generation included a sub-committee's report on chemical-laboratory practice in connection with power work. This considered laboratory work for lines of three classes: 1, large urban or interurban systems which can maintain a general laboratory, employ a good chemist and make all tests; 2, urban companies with about 100 cars or interurban lines of 75 to 100 miles which can maintain chemical apparatus for the most important tests and employ a student or recent technical graduate to give part of his time to the work; 3, small companies which cannot afford to maintain any sort of laboratory, but which should send materials to testing companies for reports. Of 12 companies (of class No. 1) nine had laboratories, and of these eight test coal, eight test oil and six test water. The paper described laboratory equipment and tests for coal, water and oil; it also gave particulars of some laboratories and specifications.

The value of uniform methods of analysis was shown, but only two of the companies use the coal analysis method of the American Chemical Society. The purchase of coal on the heat-unit basis is advisable, but for companies of the second class the same result may be obtained by purchasing on the ash basis (specifying the allowance of ash per pound of dry coal). On the basis of an article in Engineering News* on "The Mineral Analysis of Water for Industrial Purposes, and its Interpretation by the Engineer," by Herman Stabler, the committee recommended that the results of all water analyses should be expressed in the ionic form in parts per million, instead of in grains per gallon.

Rolling-stock Equipment

The Committee on Equipment (Engineering Association) presented a report covering a variety of subjects, and accompanied by proposed specifications for steel wheels and axles. These specifications were adopted by the Association, although its Committee on Standards had declined to recommend them for adoption as standard. The committee is to continue its investigations as to car wheels, and to prepare designs for standard tapes and gages for measuring the dimensions and the permissible variations or tolerances. It is also to consider the relations to each other of wheel sections and rail sections.

A lengthy appendix dealt with the subject of self-propelled cars. This was mainly a compilation of descriptive matter of various types of steam, electric and other cars, but included interesting figures as to performance and operating cost. It was pointed out that such cars are the only means of satisfying demands for frequent and rapid service in sparsely populated districts and with a minimum investment. In the discussion, remarks were made by representatives of makers of different types of cars, and particular attention was called to the great improvements in modern storage batteries, by which increased efficiency is secured in combination with a great reduction in weight.

The report suggested methods of reducing the end wear on car-axle journals: 1, by a hooded wedge, having a projection which lies against the end of the axle; 2, by stops and guides cast in the journal box. Another subject was an investigation made by the committee as to the cause of noise or squealing with steel wheels. The brakeshoe was found to be a leading factor in this, and experiments were conducted as to making the brakeshoe self-lubricating by means of inserts of different materials. Lead inserts were found the most satisfactory, and (contrary to expectation) the coefficient of friction was not reduced, but was even apparently increased. Some members, however, thought that the relative form of rails and wheels is a factor in this problem. Other interesting features of the report were as follows, and particulars of both of these we shall publish later: 1, heat-treated gears and pinions; 2, couplers for interurban cars.

Heavy Electric Traction

This committee (Engineering Association) submitted diagrams of clearance limits for third-rail lines and for automatic train stops, the former having been adopted already by the American Railway Association and the American Railway Engineering Association. It was recommended that the committee now cooperate with these other associations in investigating clearance of overhead conductors and the effect of electrolysis on metal structures.

Standards

This committee of the Engineering Association passes upon all standards suggested by other committees, and recommends or disapproves their adoption. Standards were adopted as follows: 1, couplers for interurban cars where interchange with steam roads is involved; 2, brake and end connections for such cars; 3, stranding and properties of wires; 4, specifications for lead-covered cable; 5, specifications for open-hearth girder and high T-rails (revision), and 6, clearance limits for third-rail, track, structures and rolling equipment. Proposed specifications for steel axles and steel wheels were referred back to the Committee on Equipment, and proposed sections for grooved rails (and their splice bars) were referred back to the Committee on Way, as objection has been made to some features of the rail sections. The rail specifications have been adopted already by the American society for Testing Materials.

Transportation and Traffic

The Transportation and Traffic Association has done good work in preparing standard codes of rules for the employees of city and interurban lines, and also in promoting the general adoption of these codes. These codes are harmonized, as far as possible, to insure uniformity on lines of both classes; and with the development of interurban lines and their relations with steam railways it is considered advisable to harmonize these latter rules with those of the American Railway Association. Negotiations for this purpose are in progress. Mr. Shannahan (Newport News & Old Point Ry. & El. Co.) in his presidential address stated that the interurban rules had been adopted by the Indiana Railroad Commission. The committees on rules presented certain changes in both codes, and a special set of rules applying to city lines where cars of the prepayment type are used was referred back to the committee for further consideration by members operating such cars. One rule provides for the protection of electric cars on a steam-railway crossing (without interlocking plant); the conductor and motorman must go in opposite directions on the steam road to a distance of ¼ mile and place one torpedo on the right-hand rail (facing the crossing). This formerly provided for two torpedoes, one on each rail, but the change was made to conform to the rules in force on steam railways.

The report on Train Operation, by a joint committee of the Transportation and Engineering associations, discussed the relative merits of operating with single cars, trailer cars and multiple-unit systems in city and interurban service. The committee recommended that for congested city service serious attention

* Engineering News, Oct. 1, 1908, p. 355.

should be given to the operation of two-car trains during certain periods of the day, as modern equipment makes this much more practicable than formerly, while it enables greatly improved service to be given. We shall publish an abstract of this report. In the discussion, Mr. Jackson stated that on the Public Service Ry., at Newark, N. J., a single car averages 17 sec. to cross a street intersection, while a two-car train takes only 20½ sec. The average number of stops per mile is 10 for the car and 14 for the train, while the length of stop averaged 1.7 sec. per passenger and 1.2 sec. per passenger, respectively. Mr. Case referred to the controller equipment for trail cars and multiple-unit trains, and it seems that the special advantages of the multiple-unit control system are such as to lead some companies to use this even on cars that are run singly (and not in trains).

At a joint meeting with the Accountants association, reports were presented on the handling of express and freight traffic, and on the system of accounting for this class of traffic. The plans for the 1912 census, as relating to electric railways, were outlined by Mr. Steuart, of the U. S. Census Bureau; and he requested the coöperation of a committee representing these railways (in the same way as an existing committee of the National Electric Light Association).

Engineering Accounting

The report of this joint committee of the Engineering and Accounting associations, presented a subdivision of the accounts for maintenance of equipment and for conducting transportation. The special feature in each case was the distinct separation of rolling-stock maintenance and power-plant maintenance. Some remarks were made as to the modern movement for scientific management or efficiency engineering, and an appendix gave an extended bibliography of this subject. As to cost accounting, the committee believes that costs of shop work and other department expenses should be kept in such full detail that the management may know the exact expenditure for different classes of work. Proposed blank forms for use in cost accounting were submitted with the report.

The discussion covered accounting for maintenance-of-way as well as maintenance of equipment. Mr. Clark (Cleveland Ry.) has a new arrangement by which the orders for work and instructions as to classification of accounts originate in the engineering department, but the time-keepers report directly to the auditing department. Several other speakers referred to the advantages of having time accounts of all track work kept by the auditor's office. On the Twin City Rapid Transit Ry. (Minneapolis), this system is supplemented by having a cost clerk who furnishes the maintenance-of-way department with information as to unit costs of the work. A member from Montreal explained that in view of the importance of unit costs and of knowing these costs promptly the engineering department puts young college men with the construction or maintenance gangs for the special purpose of figuring the costs and furnishing the information promptly. The time-keepers, however, make their reports to the auditing department. Mr. Boylan (Newark, N. J.) referred to the job-order system; the orders are issued by the engineering department and after the completion of the work are filed with the auditing department, which furnishes to the engineering department a monthly statement of cost.

Valuation

A paper on "Overhead Charges" was to have been read before the Accountants Association by M. E. Cooley (Dean of the Dept. of Engineering, University of Michigan), but owing to illness he was unable to prepare this or to be present. However, there was some discussion on the subject, based on a similar paper presented by Prof. Cooley at the convention in 1911. Mr. Young (Public Service Ry., Newark, N. J.) referred to the fact that such charges form a large proportion of the total cost and the total value of the property, but that there is great difference of opinion as to what the proportion is and what are the various items to be included, the general tendency being to underestimate the total. He thought that the accountants should undertake to make clear the facts in the case. Another paper of special interest in this connection was on "Intangible Values of Electric Railways, and their Determination from Accounts," by Wm. J. Hagenah (Chicago).

Life of Railway Property

This joint committee of the Engineering and Accountants associations submitted a classification of physical property for general use, to insure uniformity and enable comparisons to be made on a common basis. This comprised 60 items under five general divisions: 1, buildings and structures; 2, equipment (car and shop); 3, power distribution; 4, power generation; 5, way and track. The committee pointed out that it is not practicable to compile any standard table of life of property which will be applicable at all places and under all conditions. Mr. Simmons, formerly of the Milwaukee Elec. Ry., spoke of his experience with the valuation of property, and stated that the life of a car (for example) would vary in different parts of the country, in cities of different size and under various other conditions. Thus it would be impossible to strike a general average which would be of value as representing average life under any and all conditions. An important line of work would be to compile statistics from various valuations, rather than to attempt to combine or average these statistics.

Safety and Accidents on Electric Railways

The annual address of the President of the Claims Association, Mr. Bennett (Fitchburg & Leominster St. Ry.) referred to the work of the Safety League Committee in organizing a "safety league" as a means of inculcating ideas of care and responsibility, and so reducing the number of accidents and the resultant claims for damages. The education of employees and the public (and especially of school children) on these lines was discussed, and a report of a committee on the training of transportation employees was presented at a joint meeting of the Claims Association and the Transportation Association. Another subject was the relation of the claim department to other departments of the railway service. The organization and operation of a medical department of large street-railway systems was dealt with in a series of papers which discussed the subject from different points of view. An address on the modern movement or campaign to secure greater safety to life, limb and health was delivered by Dr. Tolman, of the American Museum of Safety; he also outlined the work of this institution, whose operations are divided into three main divisions: accident prevention, industrial hygiene and social hygiene. He asked for the coöperation of the electric-railway associations in maintaining a permanent exhibit of safety devices in connection with electric railways.

The new Welland Ship Canal to be built between Lake Erie and Lake Ontario to replace the present Welland Canal is to have a depth of 30 ft. of water over the lock sills. The difference in elevation between the two lakes will be overcome by seven lift locks having dimensions of 800 ft. in length by 80 ft. in width, with a lift of 46½ ft. The total length of the canal will be about 25 miles and the location in general follows the line of the present canal from Port Colborne, on Lake Erie, to Thorold, about 17 miles. The line runs then to McCalla's Grove, on Lake Ontario, a point about three miles east of the entrance to the present Welland Canal at Port Dalhousie. The locks on the new canal will all be located in this northern stretch of eight miles. The present Welland Canal is crossed on the level below lock No. 11. Small size vessels, therefore, can use either entrance from Lake Ontario. The completion of this canal will enable the largest size lake steamers to pass from Lake Erie to Lake Ontario with very little detention as regards time on account of the small number of locks. The present Welland Canal only accommodates vessels of about 2000 tons capacity. Passage through it is very slow on account of the large number of locks. Mr. J. L. Weller, of St. Catharines, Ont., is the engineer in charge of the construction of the new Welland Canal.

Engineering Works of Kyoto, Japan

By S. Tanabe*

The city of Kyoto is situated in the central part of Japan, near Lake Biwa, which, covering an area of 400 square miles, is 280 ft. above the sea. It is one of the three principal cities, and has a population of 450,000. It is famous for its beautiful scenery, fine arts, old temples and its historic remains, the city being eleven centuries old. Kyoto is the place where the coronation ceremony of our new emperor will be held next year.

A canal from the lake to the city (7 miles long), and from the city to the town of Fushimi (5½ miles long), with a branch line, were constructed (1885-1890) by the author, and its hydro-electric power plant was one of the earliest in the world. (See Eng. News, Apr. 13, 1893).

Increased demands for electric power and the requirements of the city water-supply called out the design, also made by the author, for the construction of a new aqueduct, a new hydro-electric power plant and a water purification plant. Widening of streets and running of electric street cars on these streets were also proposed. These works were commenced in 1908 and successfully completed in June of this year (1912). (See Eng. News, July 4, 1907).

[We reproduce as Fig. 1, a portrait of Professor Tanabe, taken in June, 1912, which includes a view of a gift made to him by the Emperor of Japan in recognition of his engineering services.—Ed.]

*Professor of Civil Engineering, Kyoto Imperial University; Honorary Adviser, Kyoto Municipal Engineering Works, Kyoto, Japan.

The high level portion of the new aqueduct, 6½ miles long, is entirely of tunnel and reinforced-concrete covered way, 13 ft. wide, 13½ ft. high with 10 ft. depth of water. The average slope is 1 in 2200. Near the end of the high-level canal the new hydro-electric power station is built. Two 88-in. riveted steel

Fig. 1. Portrait of Prof. S. Tanabe and View of Gift to Him from the Emperor of Japan in Recognition of His Engineering Services

pipes feed 750 cu.ft. per sec. of water to the new power station where five 1700-hp. waterwheels (one in reserve) and two exciters are run with 106 ft. effective head. Each waterwheel is coupled direct to a 1500-kv.a. dynamo, 6600 volts, 60 cycles.

The low-level canal from Kyoto to Fushimi, 5½ miles long, was widened so as to convey the water of the old and the new canals. Another hydro-electric power station is now in course of construction at Fushimi, the power of which will be used exclusively for the working of electric street cars. These canals afford navigation between the lake and river Yado at Fushimi.

A part of the water of the new aqueduct is conveyed to a filtration plant situated near the end of the high-level canal. Mechanical filters are used, with sulphate of alumina as a coagulant. A view of the coagulation plant is shown by Fig. 2.

The settling reservoir, with walls of reinforced concrete, is 126x216 ft. in plan and is divided into two compartments. The 20 filters, each 21 ft. in diameter and 7 ft. deep, are also made of reinforced concrete.

The lower part of the city is supplied by a direct gravity service while the water pumped to a high-service reservoir, by electric centrifugal pumps, feeds the higher district of the city.

The length of streets widened amounts to 15 miles. Electric cars on these streets are run by electricity generated by the power station already mentioned.

The various works described cost about $10,000,000, of which a French loan supplied 35,000,000 francs. The revenue from these enterprises is expected to be large.

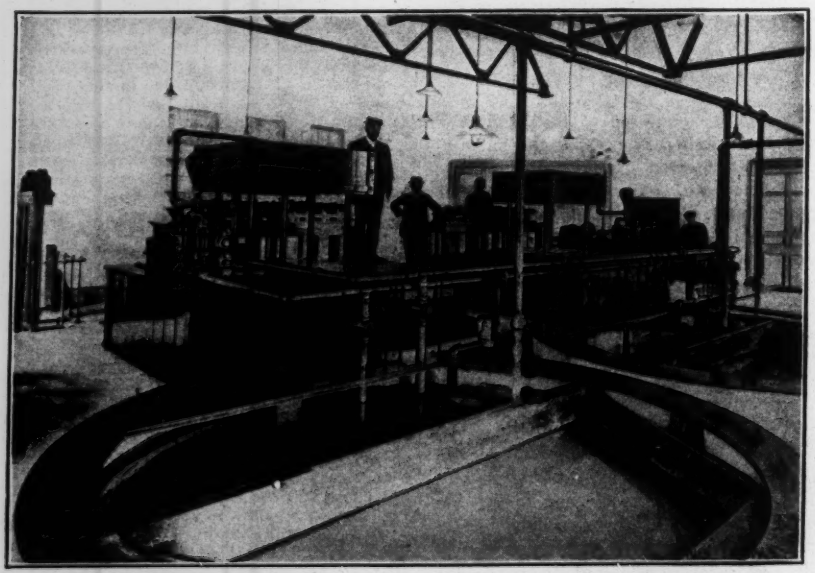

Fig. 2. Coagulation Plant of the Water-Purification Works, of Kyoto, Japan

In a Railway Disaster at Alicante, Spain, on Oct. 5, 9 persons were killed, 22 seriously injured and a number badly bruised and shaken up. A passenger train going down a steep grade was derailed, just before reaching the Alicante station, and the derailed locomotive is reported to have crashed into the station buildings, injuring the ticket agent among others.

Fog Caused a Wreck on the Baltimore & Ohio R.R. near Chicago Junction, Ohio, on Oct. 10. Passenger train No. 14, eastbound from Chicago to New York, ran into a train of cars, left standing on its right of way during some switching operations. The passenger locomotive and two mail cars were derailed, and the engineer and fireman were killed and five mail clerks injured in the wreck.

A Bad Fire at the Piers of the Standard Oil Company at Bayonne, N. J., occurred on Oct. 10. Two men were drowned and one burned to death as a result of the fire, which entirely destroyed three large oil ships, injured two others, and placed in danger the immense plant of the company, which extends for several miles along the New Jersey shore. The damage through the loss of the three ships is estimated at about $600,000.

A Powder Explosion at Tampico, Mex., on Oct. 7 is reported to have killed 50 persons and inflicted more or less serious injuries on about 100 others, according to press dispatches from Galveston, Texas. The explosion came during, and as a result of a fire in a government warehouse, and most of the killed and injured were among the spectators who had gathered to watch the fire.

Another German Dirigible Exploded on Oct. 10 and was completely destroyed, along with the shelter house in which it

was stored. This air ship was of the semi-rigid type with internal air ballonets to preserve its shape. It was being filled with hydrogen at the time of the accident and although the damage to the balloon and to the building was so great, none of the crew were injured.

The Westport Accident on the New York, New Haven & Hartford R.R., described in our issue of last week, was the subject of a two-day's hearing by the Interstate Commerce Commission, in New York City, Oct. 8 and 9. Mr. Charles F. McChord, member of the Commission, was in personal charge of the investigation. The chairman and chief engineer of the Connecticut Public Utilities Commission were also present. The chief witnesses were H. J. Horn, Vice-President of the New York, New Haven & Hartford R.R., in charge of operation, and Charles H. Morrison, Signal Engineer. Mr. Horn is reported by the New York "Evening Post" to have testified that the railway company had considered the recommendation of the Commission in the report on the Bridgeport accident of 1911 regarding the use of longer crossovers, but had decided this would be a step backward, and that it had seemed best to put all dependence on signals. Mr. Horn also testified that the suggestion to have trains come to a full stop before going over a crossover switch was considered but seemed inadvisable because of the danger of substituting a different kind of accident for a possible derailment. When questioned about automatic train stops, Mr. Horn stated that his company had made no experiments with them. Mr. C. H. Morrison, Signal Engineer, testified that the third-rail shoe on the New Haven Co.'s electric locomotives, for use on the New York Central tracks in New York City, prevented an automatic stop attachment except outside the shoe, which would then make the apparatus too wide for clearing many through plate-girder bridges on the New Haven Co.'s tracks. The substance of the testimony was that the accident was entirely due to the disregard of the signals by the engineman; and the remedy the railway company would apply was "a stiffening up of discipline." The division superintendent testified that the engineman of the wrecked train had once been dismissed for a collision at New Haven, and had received demerits on another occasion for running by a signal. Other evidence went to show that speed rules at drawbridges and crossovers were habitually violated.

New Freight Terminals at Chicago are to be built at a cost of several million dollars, the principal feature being outlying yards to eliminate the present congestion of city terminal yards. This work will be carried out as part of the extensive improvements proposed by the Chicago & Western Indiana R.R., as described in our issue of May 9, 1912; it will include the purchase and development of the large gravity switching yard at Clearing, and improvements on the lines of the Belt R.R. of Chicago and the C. & W. I. R.R. The latter company has perfected plans for the issue of bonds for $200,000,000 to provide for the various works and to refund existing bonds. This is a terminal and not an operating company, and until recently five of the trunk lines entering Chicago have been its stockholders. Seven other lines have now been added to the list, so that the new terminal system will be built and operated in the interests of these twelve lines acting in cooperation. The fixed charges will be borne in proportion to the respective use of the terminals. The original railways included are the Wabash, Grand Trunk, Erie, Chicago & Eastern Illinois, and Chicago, Indianapolis & Louisville. The new railways represented are the Illinois Central, Chesapeake & Ohio, Pennsylvania Lines, the Chicago, Rock Island & Pacific, the Chicago, Burlington & Quincy, the Atchison, Topeka & Santa Fe, and the Minneapolis, St. Paul & Sault Ste. Marie (Canadian Pacific.)

The Irondequoit Creek break on the New York State Barge Canal was finally closed on Oct. 15 and the long string of waiting boats let through the temporary flume. The break occurred Sept. 3, as noted in recent issues of Engineering News.

The New Jersey State Water Supply Commission has ordered an appraisal to be made of the value of the property of the East Jersey Water Co. and the Elizabeth Water Co. A Committee has been appointed to make the appraisal, consisting of Messrs. Clemens Herschel, Dabney H. Maury and Nicholas S. Hill, Jr. They will act in coöperation with Morris R. Sherrerd, the Commission's Consulting Engineer.

A Third Attempt to Build a Dam that will stand is now being made on Black River, just below the outlet of Lincoln Pond, in the southeast corner of Elizabethtown, Essex County, N. Y.* There is good promise that this dam will be a success, for, unlike the other two, it has been designed by an engineer.

The new dam will have a maximum height of 22 ft., length of about 400 ft., with a spillway 20 ft. high and 45 ft. long. It is being built of concrete of 1:2½:5 proportions with large stones embedded. Reinforcement of steel bars is used at the intake section, also in strengthening a portion of the old dam remaining in place. Construction was begun on Sept. 9, and it is expected that it will be completed by Nov. 15. This dam, while but a comparatively small structure of itself, forms part of a storage proposition of considerable magnitude, impounding about 600,000,000 cu.ft. of water and forming a pond about three miles long and about one-half mile wide. A 32-in. diameter steel penstock is carried about 15,000 ft. downstream to the power house, where an 800-kw. generator is driven by a Pelton wheel under a head of 510 ft., forming what is very likely the highest head water power development in New York State. Mr. Charles T. Middlebrook, 68 State St., Albany, N. Y., is engineer for the dam.

A 240,000 Kw. Generating Station is being projected by the Commonwealth Edison Co. of Chicago, Ill., to be known as the Northwest Plant. When completed this plant will consist of two similar groups of buildings, each containing six 20,000 kw. generating sets, arranged on the unit system, with boilers and auxiliaries for each set practically independent. The turbines are of the vertical type and will generate about 30,000 hp. each. Ten boilers with 5600 sq.ft. of heating surface apiece, will feed each turbine. The estimated cost of the entire project is about $20,000,000 or approximately $83.50 per kw.

Warning against Frozen Concrete is given by the Trussed Concrete Steel Co., Detroit, Mich., in the following circular addressed to its patrons:

CAUTION

Placing Concrete During Fall and Winter Months

At this season of the year the greatest care must be exercised in using reinforced concrete. Cool weather, with its attending atmospheric conditions, even though not freezing, has a bad effect on concrete. The following points are worthy of special consideration:

1. During cool weather, even though not freezing, the setting of cement is delayed. Sometimes two weeks or more after placing, it is possible to drive a nail into the concrete, which indicates how serious is this delay in the setting. The only sure way of knowing when the cement is fully set and the concrete **properly** hardened is to actually test it with a hammer for hardness. To do this, it is necessary to remove small portions of the form work in each section of the structure to be certain that there are no soft spots. Bear in mind, this delay and indefiniteness in the setting of cement is not due to freezing, but merely to medium cold weather and attending atmospheric conditions.

2. Be careful to avoid freezing of the concrete. While the days may not be particularly cold, the nights are often below freezing temperature. Therefore, protect all freshly laid concrete by covering it with some material that will prevent freezing. Be especially careful to protect this concrete during the nights. It is said, and may be true, that frozen concrete will reset under certain conditions, but it is not advisable to depend upon such an uncertainty. The safest plan is to entirely avoid freezing. If absolutely necessary to place concrete during freezing weather, the materials such as sand, stone and water, should be heated and the placing of concrete so protected as to keep its temperature above freezing.

3. Workmen are apt to become careless during cold weather. They have a tendency to shirk their duty, especially when it exposes them to the cold. Therefore, particular care should be used by the superintendent in charge, to see that the forms are properly braced, that the bottom of beam and column boxes are clean before pouring concrete, that the steel is accurately placed, concrete thoroughly mixed and the workmanship in general the best possible. Special vigilance is required of the superintendent at this season of the year.

4. The most important point, and one whose importance cannot be over-estimated, is caution in the removal of the form work. Don't remove any forms until absolutely certain that the concrete is thoroughly hardened and that no portion is either soft or frozen. Even after you are certain that the concrete is hard, then remove the forms very carefully and without shock to the structure. Always leave in place a few intermediate posts so as not to place the entire dead weight too suddenly on the beams and columns.

We cannot emphasize too strongly the importance of special care at this season of the year to be certain that the concrete is thoroughly set and hardened before the removal of the form work and to guard against the treacherousness of the fall and winter weather in its effect on concrete work.

Panama Canal Excavation during September totaled 2,124,440 cu.yd., a daily average of 88,518 cu.yd. for each of the 24 working days in the month. Rainfall for the month was 12.13 in. The amount of concrete laid in September was 53,411 cu.yd., and 278,551 cu.yd. of fill were placed in dams.

Personals

Mr. Robert M. Black, M. Am. Inst. M. E., formerly Instructor in civil engineering at the State University of Iowa, has been appointed Assistant Professor of mining at the University of Pittsburgh.

Mr. Robert C. Falconer, Division Engineer of the Erie R.R. at Jersey City, N. J., has been appointed Principal Assistant Engineer of the lines east of Salamanca, N. Y., with headquarters at New York City.

Col. R. A. Marr has resigned as Dean of the engineering department and Professor of civil engineering at the Virginia Polytechnic Institute to become

*A description of the second failure of a dam at this site, late in May, 1912, appeared in our issue of June 6, 1912. The first failure occurred in April, 1909.

Consulting Engineer for the Marr Wood Preservation Processes, at Richmond, Va.

Mr. Kern Dodge, formerly of the firm of Dodge, Day & Zimmermann, Consulting Engineers, of Philadelphia, Penn., has returned from a year's travel in Europe and has opened an office in the Morris Bldg., Philadelphia, as a consulting engineer.

Mr. Emile Reed Low, son of Mr. Emile Low, M. Am. Soc. C.E., was married on Oct. 9, to Miss Marie F. Fox, of Buffalo, N. Y. Mr. Low, Jr., is a civil engineering graduate of the University of Michigan and is connected with the Beaver Board Co., of Buffalo.

Mr. J. B. Rohrer, M. Am. Soc. C.E., who for some months past has been in Ecuador, South America, investigating engineering projects in the Andes Mountains, has returned to his home at Lancaster, Penn., and resumed his practice as a consulting engineer.

Mr. C. K. Mohler, Consulting Engineer, of Chicago, Ill., has been appointed Chief of the Railway Bureau of the Board of Public Utilities, Los Angeles, Calif., and will have charge of the work of appraising the railway property of the city and the regulation of fares.

Mr. Charles H. Hoyt, Consulting Engineer, of Washington, D. C., has been admitted to the bar of the Supreme Court of the District of Columbia. Mr. Hoyt has received the degrees of L. L. M. and Master of Patent Law from the National University, Washington, D. C.

Mr. A. M. Darlow, formerly Mechanical Engineer of the Buffalo & Susquehanna Ry., has been promoted to be Superintendent of Motive Power, at Galeton, Penn. Mr. Darlow graduated in mechanical engineering at Cornell University in 1906 and began railway work as a special apprentice and shop draftsman with the Chicago & Eastern Illinois R.R.

Mr. R. S. Charles, formerly Division Engineer of the Chicago & Eastern Illinois R.R., at Salem, Ill., has been appointed Chief Engineer of the Texas Land & Development Co., at Plainview, Tex. This company is agent for English capitalists in charge of the development of 60,000 acres of land in Hale County by means of irrigation from wells.

Obituary

A. J. Neracher, Department **Engineer** of the General Fire Extinguisher Co., Chicago, Ill., died recently in that city.

Eugene G. Perkins, Division Superintendent of the Chicago, Milwaukee & St. Paul Ry., at La Crosse, Wis., died Oct. 6, at his home in that city.

B. R. Wallace, Chief Engineer at the Hebgen dam of the Montana Reservoir and Irrigation Co., near the Yellowstone National Park, was very seriously injured on Oct. 6, by being drawn into the gears of a 25-hp. concrete mixer. Mr. Wallace was superintending operations at the dam, and in passing near the mixer his overcoat was blown by the wind into the machinery. Several bones were broken and internal injuries to the lungs and abdomen proved fatal; he died Oct. 8. Mr. Wallace graduated fro mthe Iowa State College at Ames in 1905, and for several months was employed as Cement Inspector for Waddell & Hedrick, Kansas City, Mo. Later he was engaged in bridge work at Dallas, Tex. Since January, 1910, he had been with the Montana Reservoir & Irrigation Co., in charge of the large reservoir and dam at Lyon, Mont. He leaves a widow and two young children.

Engineering Societies

COMING MEETINGS

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 21-25. Annual meeting at Chicago, Ill. Secy., T. A. Andreucetti, C. & N. W. Ry., Chicago, Ill.

AMERICAN ASSOCIATION FOR THE PREVENTION OF THE POLLUTION OF RIVERS AND WATERWAYS.
Oct. 23-24. Annual convention at Cleveland, Ohio. Secy., H. De B. Parsons, 22 William St., New York.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 28-31. Annual meeting at Cleveland, Ohio. Secy., Joseph Struthers, 29 W. 39th St., New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 29 So. La Salle St., Chicago, Ill.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Annual meeting at New York, N. Y. Secy., D. H. Cox, 29 W. 39th St., New York.

AMERICAN MINING CONGRESS.
Nov. 25-28. Annual convention at Spokane, Wash. Secy., J. F. Callbreath, Denver, Colo.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 2-3. Annual meeting at New York City. Secy., W. H. Ross, 154 Nassau St., New York.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Dec. 2-5. Annual meeting at Atlanta, Ga. Secy., Louis Stotz, 29 W. 39th St., New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 3-6. Annual convention at Cincinnati, Ohio. Secy., E. L. Powers, 150 Nassau St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 3-6. Annual meeting at New York City. Secy., C. W. Rice, 29 W. 39th St., New York.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 4-6. Annual meeting at Detroit, Mich. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Annual convention at Philadelphia, Penn. Secy., C. A. Prosser, 105 E. 22d St., New York.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 9-12. Annual meeting at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Penn.

American Association for Highway Improvement—The Association changed its name to the American Highway Association, by constitutional amendment, during the recent congress at Atlantic City, N. J. The following officers were elected for the year 1912-13: President, [illegible] Page; Vice President, W. W. [illegible]; Secretary, J. E. Pennybacker, Jr.; Treasurer, Lee McClung.

Illuminating Engineering Society—The Pittsburgh Section met on Oct. 11 and abstracts of the following papers were given, followed by discussion of the same: "Modern Illumination in the Iron and Steel Industry," by C. E. Clewell; "The Incandescent Lamp in the Steel Industry," by Ward Harrison; and "Curves and Data for Illumination Calculations," by C. J. Mundo.

On Oct. 10 the New York Section met for discussion of the papers on "Present Practices in Small Store Lighting," by Law and Powell, and "Symposium on High Pressure Gas," by G. S. Barrows.

St. Louis Railway Club—The feature of the Club meeting on Oct. 11 was an address on "Accident Prevention and Workmens' Compensation," by F. C. Schwedtman, Chairman of the Committee on Industrial Indemnity Insurance, of the National Manufacturers' Association of the United States.

Brooklyn Engineers Club—At a meeting of the club on Oct. 10, a paper was presented by John B. Stein on "The Topographical Bureau of the Borough of Brooklyn, City of New York."

Cornell Society of Civil Engineers—The annual meeting of the Society was held at the Cornell University Club, 65 Park Ave., New York City, on Oct. 15.

American Society of Civil Engineers—At the meeting of the Society on Oct. 16 the following papers were presented for discussion: "A Brief Description of a Modern Street Railway Track Construction," by A. C. Polk, and "Construction of a High-Service Reservoir at Baltimore, Md.," by P. A. Beatty.

The Colorado Association met on Oct. 12 and a paper was presented on "The Construction of the Minnequa-Wakenburg Double Track Line," by A. O. Ridgway.

American Society of Mechanical Engineers—The following nominations for the coming Society election have been announced: For President, W. F. M. Goss, Urbana, Ill.; Vice-Presidents (two years), James Hartness, Springfield, Vt., F. E. Moultrop, Boston, Mass., H. G. Stott, New York; Managers (three years), W. B. Jackson, Chicago, Ill., H. M. Leland, Detroit, Mich., Alfred Noble, New York; Treasurer, W. H. Wiley.

American Institute of Electrical Engineers—Papers on "The Use of Reactance in Transformers," by W. S. Moody, and "The effect of Temperature upon Hysterisis Loss in Sheet Steel," by Prof. Malcolm MacLaren were delivered at the Institute meeting on Oct. 11.

International Association for the Prevention of Smoke.—The officers elected at the recent annual convention are as follows: President, J. P. Brown, City Smoke Inspector, Indianapolis, Ind.; Vice President, J. M. Searles, Pittsburgh, Pa.; Secretary and Treasurer, John Krause, City Treasurer, Cleveland, O.

American Institute of Mining Engineers—The adjourned business meeting of the Institute, from Feb. 19-20, was held on Oct. 7, and a series of amendments to the constitution and by-laws, was introduced by C. R. Corning. These amendments will be printed, so as to be available for discussion at the Cleveland meeting on Oct. 28-31. The next business meeting will be held in New York City on Nov. 12.

Engineering Literature

CONTENTS

Page

ARTICLE:
The Library as a Business Asset.. 735

REVIEWS:
Brueckeubau. Reviewed by Lewis J. Johnson 735
The Design of Mine Structures. Reviewed by R. V. Norris..... 736
Southern Industries 737
Machine Design. Reviewed by John J. Flather..... 737
Elementary Principles of Reinforced-Concrete Construction.... 737
The Effects of Errors in Surveying. Reviewed by Charles L. Crandall 738
The Hydrometallurgy of Copper. Reviewed by Stuart Croasdale.. 738
Propellers. Reviewed by D. W. Taylor 739
The Primer of Hydraulics. Reviewed by John H. Gregory..... 739
Railway Transportation. Reviewed by Charles Hansel..... 740
Freight Terminals and Trains..... 740
Materials and Construction..... 742
Diesel Engines for Land and Marine Work 743
Commercial Engineering for Central Stations 743
The City That Was..... 744
Reinforced-Concrete Construction 744
Railroad Finance 744
Railroad Operating Costs..... 745
American Machinist Grinding Book. Reviewed by William W. Bird.. 745
Shop Mathematics 745
PUBLICATIONS RECEIVED..... 746

ARTICLE

The Library as a Business Asset*

By D. N. Handy†

Let us at the outset agree that when we speak of the library as a business asset, we speak not of its value as so many books and pamphlets, but of its value as a contributing agency to those more fundamental possessions to which material assets owe their existence. What then, has the library contributed and what may it in the future hope to contribute that will add to business courage, integrity, competency, peserverance? In a word, to business efficiency?

The library as a business asset is not *any* collection of books and pamphlets under *any* custodian and handled probably more often by the janitor than the manager.

At no time in the history of the modern business world, has the opportunity been so favorable for a lasting alliance between the library and business. Business wants its own technology; it wants pamphlets, clippings, reports—all sorts of special things which no public library with all its other obligations could ever hope to get and to classify.

If the library is to help business, it must be organized as business is organized. To get everything on a subject may be necessary for some purposes, and is always interesting to the bibliographer; but to get the *adequate* thing is the business librarian's ideal of service, and if he misses it he may wake up surprised to find his labor unappreciated.

Business is multiplying short-cuts, motion-savers, "efficiency" getters in every department; it will tolerate nothing less from the library. It is for the library to prove its value—to demonstrate its practical worth by adjusting itself to the business environment. It must not follow too closely the traditions of general library work. It ought to be familiar with general library methods; but it should never lose sight of the fact that general library methods were devised with an eye single to general library problems. The problems of a business library are different.

Finally, how are the library and business to coöperate for their mutual advantage? It is evident that in this respect business has to perform a duty even greater than we have laid upon the library itself. If the library is under obligation to adapt itself to the needs of business, business is under special obligation to place its resources more completely at the disposal of the library. It must take the library seriously and plan for it accordingly.

Business fails to appreciate the ally that it might have in the well conducted library. It appreciates and at times is mildly grateful for the library's service; but it has shown no great discernment when it came to an understanding of the means by which the service was rendered. It asks for and expects results; but has little appreciation of the price at which results must be bought.

An indispensable requisite of a business library is a librarian thoroughly conversant with the main facts of the business. He must know its theory and history. He must be freed from routine at least to the extent necessary to enable him to become an expert in the materials which he handles. He must be treated as a literary adviser and given the opportunity to develop literary discrimination and judgment in the field which he covers. Then he becomes more than a custodian of books; he is a counsellor, impressing his personality upon a unique source of business inspiration, namely, the business literature of his collecting, and bringing direct to his superiors the information which they will know how to use for the good of the business as a whole.

Subordinates, working under him, will assemble, classify, card index, bulletin and distribute, while the library itself will stand on a level with manufacturing, accounting and selling. It will be a department of the business, organized like other departments, for efficiency.

Business has already awakened to the possibilities of library help, and wherever it has done so with insight and courage it has answered for itself the question which we have here proposed. In banking, in finance, in engineering, in applied chemistry, in insurance and in numerous other fields, business has set itself to the task of adapting library methods to business needs. Special collections administered for special requirements are springing up in every large city, and the liberality with which these are beginning to be supported is in some respects an indication of business' own estimate of their value.

*Condensed from a paper read before the Special Libraries Association.

†Librarian of the Insurance Library Association, Boston, Mass.

REVIEWS

Reinforced Concrete Bridge Construction

Reviewed by Lewis J. Johnson*

BRUECKENBAU—Being Vol. VI of the "Handbuch für Eisenbetonbau." Second edition. Dr.-Ing. F. von Emperger, Editor-in-Chief. By W. Gehler, Th. Gesteschi and O. Colberg. Berlin: Wilhelm Ernst & Sohn. Paper; 7¼x10¼ in.; pp. xvi. 1766; 1695 text illustrations. 30 M. cloth, 33 M. American price, $12, and $13.20. net.

This bulky but most attractive volume forms one of the set of 12 similar volumes and a supplementary volume which together compose the great treatise on reinforced-concrete construction entitled "Handbuch für Eisenbetonbau." The whole work is under the editorial direction of Dr. F. von Emperger also editor of the well known technical periodical, *Beton u. Eisen.* The set of books, which we in English should be more likely to call a cyclopedia than a handbook, is on the same plan as the monumental "Handbuch der Ingenieurwissenchaften," and does for its field, concrete and reinforced-concrete construction, what the larger

*Professor of Civil Engineering, Harvard University, Cambridge, Mass.

work does for the larger field, and in equally thorough and finished style.

The title of the book is somewhat misleading. Though entitled bridge construction, it treats only highway bridges and foot bridges. Bridges to carry railways and canals are included in other volumes of the Handbuch.

Out of the corps of 30 to 40 of the most eminent German-speaking specialists whose signed contributions go to make the 13 volumes composing the whole Handbuch, three have a share in this particular volume. They are Regierungsbaumeister W. Gehler, director of the Dyckerhoff & Widman Co., Privatdozent at the Royal Saxon Technical High School of Dresden; Th. Gesteschi, civil engineer, of Berlin, and O. Colberg, Regierungsbaumeister retired, instructor in the state Technikum at Hamburg.

The volume accordingly includes three parts, one by each of these specialists.

Part (Ger. *Kapitel*) I, by Gehler, covering 330 pages, is devoted to work of the girder or non-arch type, including not only bridges in the ordinary sense, but also such extensive flooring work (Überdeckungen) as is used for covering subways, or watercourses traversing cities under streets, or reservoirs, etc. Part II, by Gesteschi, include 345 pages on arch bridges. Part III, by Colberg, gives 52 pages to the use of concrete in connection with structural steel for bridge purposes.

Part I (Girder Bridges) includes six subdivisions:

A. Introduction, 9 pp.
B. Classification of Types of Girder Bridges, 37 pp.
C. General Features of Design, 61 pp.
D. Construction, 10 pp.
E. Statical Analysis of Girder Bridges, 146 pp.
F. Description of Existing Structures, 67 pp.

Part II (Arch Bridges), besides six subdivisions, practically paralleling those of Part I both in subject and distribution of emphasis, includes a 14-page tabulation of data regarding the most important concrete and reinforced-concrete arch bridges of the world. The increased space taken by Part II is due mainly to nearly three times as much space being given in this Part to the description of existing structures. This increased demand for space is largely offset by the covering of statical analysis of arches in only a little over a third of the space given to girders in the preceding Part.

Part III (Application of Concrete in Steel Bridge Work) has five subdivisions:

A. Combination Structures of Steel and Concrete. 3 pp.
B. Bridges involving Reinforced Concrete, 19 pp.
C. Strengthening of Old Steel Bridges with Concrete and Reinforced Concrete, 2 pp.
D. Strengthening of New Steel Bridges with Reinforced Concrete, 18 pp.
E. Use of Reinforced Concrete in Piers and Abutments of Steel Bridges, 9 pp.

It should be noted that the descriptions of existing structures refer to no less than 55 girder bridges and 75 arch bridges, mainly European, of course, but with fair regard to American work. Accompanying the text in these cases are many beautiful halftone pictures of the structures described. These pictures, with the accompanying data, are well calculated to be of invaluable service, not only as suggestions and precedents to aid the designer, but also as means of showing that reinforced-concrete structures can be beautiful as well as otherwise desirable.

Although this volume is only one of a set of 13 on the whole larger subject, it is for practical purposes a unit by itself. It goes pretty well back into the mechanics of beams, but leads rapidly up to a very full treatment of maximum stresses in highway bridges, with special regard to combination loadings of crowds, road-rollers, etc., such as the subject of the work requires.

The statical analysis and dimensioning both of girder bridges and arch bridges are clearly and fully worked out and with an ample supply of numerical examples. These examples cover everything from the simplest beams to continuous girder bridges, and bridges with girders composed of ribs consisting of monolithic combinations of flat girders and vertical end ribs (Ger. *Rahmenträger*), and even the very modern type of reinforced-concrete truss which involves the rectangle instead of the triangle as the framing unit—i.e., is made up on the lines of Pratt trusses but minus all diagonals—to say nothing of cantilever bridges and the usual array of arches with and without hinges.

Besides the catalogue of data regarding important arch bridges above specially mentioned and dealing with 132 structures, including, among other recent works, the new Charles River Bridge of the Boston Elevated Ry. and the great 100-meter span Risorgimento Bridge in Rome, mention should be made of a similar tabulation of data concerning 78 bridges of the girder type.

One risks little in expressing the opinion that, for one who has some command of German, this book is unsurpassed and probably unequalled as a collection of data and instruction bearing on concrete highway bridges. To be sure, much of the matter given in this work can be found scattered through periodical literature, but this book renders accessible in small space and in most attractive form what would otherwise be practically useless to most engineers.

As for proofreading, workmanship and mechanical finish one need only say that it is in the best class of German engineering books. Better than that could hardly be wished.

In a word, no engineer who has to do with the design of reinforced-concrete highway bridges should fail to consult this fine work. Even if he knows little or no German, he can at least get valuable suggestions and inspiration to tasteful work from its pictures of the many beautiful reinforced-concrete bridges now existing. And that is a field in which perhaps he would have most to learn.

Mine Structures

Reviewed by R. V. NORRIS*

THE DESIGN OF MINE STRUCTURES —By Milo S. Ketchum, C. E., M. Am. Soc. C. E.; Dean of College of Engineering and Professor of Civil Engineering, University of Colorado; Consulting Engineer. New York; McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xvi + 459; about 250 text figures and many tables. $4, net.

Prof. Ketchum says in his preface that this "book is written for the young engineer or student who has had a thorough course in applied mechanics and statics, and for the structural engineer who wishes to become familiar with this much neglected field." In following out his plan he has supplied a unique collection of drawings and photographs of typical structures of a type rarely described, and then only in scattered articles in the technical press, and has added to this collection an analysis of the methods of design which is very valuable.

The work is divided into three parts, dealing with Head Works for (I) Mines, (II) Mine Buildings and (III) with the Design and Cost of Mine Structures. Three appendixes give specifications for structures of steel, timber and reinforced concrete.

In Part I, which occupies 194 of the 459 pages, lies the principal value of the work to the practicing engineer, as it contains not only a very valuable collection of drawings and photographs of head frames and tipples, but a convenient assemblage of the mathematical formulas involved in the design of both simple and statically indeterminate head frames. Chapter II, on hoisting, contains a brief summary of methods which might well have been extended and includes tables of wire-rope strengths, formulas for total loads and Sederholm diagrams showing the increase of strain due to bending over sheaves. The tables of weights of sheaves are also convenient and not readily obtainable elsewhere.

In Chapters III to V are found the mathematical discussion of the strains involved. These are in clear form and are of great value not only to the student but to the designing engineer who may have occasion to calculate the strains in structures of such unusual type. This is particularly the case with the discussion of the strains in statically indeterminate structures, to which class, unfortunately, the majority of head frames almost necessarily belongs. In Chapter VI the detail design of a head frame is worked out, primarily for the benefit of

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students. This is evidently taken from a design by the author, as in many instances the assumed sections have been accepted despite calculations showing them to have unnecessary weight, the extra material being properly justified by convenience in construction or the reduction of probable vibration. The chapter also contains further valuable drawings of existing structures. It is unfortunate that the author has not included the modern types of steel head frames in use in the Wisconsin iron region, and in the anthracite region of Pennsylvania.

Chapter VII, on the design of coal tipples, is too brief in the exposition of the principles of design, but contains useful drawings of tipples showing the method of construction.

Part II, on the design of mine buildings, is a brief resumé of the author's previous publications. The greater portion of this is manifestly written for the student. Older engineers would prefer to use more extended works on the subject, and to them the value of this part of the work is rather in the detail drawings of bins and pockets than in the discussion of roofs and retaining walls.

The discussion of anthracite preparation, covering but four pages (Chapter XII) was evidently written before the publication of Mr. Sterling's excellent paper on the subject (*Trans.* Am. Inst. M. E., Oct., 1911, pages 749 to 798), which the student would do well to substitute for this brief resumé. That the author was not familiar with the Pennsylvania practice is shown by the much greater space devoted to the Montana Cottonwood breaker, and by numerous inaccuracies in statements on this subject.

The only justification of Part III, on Design and Cost of Mine Structures, is in its usefulness to students, as practically all the data are, or should be, readily available to practicing engineers.

The three appendices, specifications for various types of structures, are general rather than detailed and would require rewriting and extension in practice.

A good index adds materially to the value of the work, which is evidently primarily intended as a textbook for students, but is well worthy of a place in the library of any engineer interested in the design of mine structures, particularly of head frames.

SOUTHERN INDUSTRIES—The Tradesman Classified Directory and Buyers' Guide for 1912. Issued as The Tradesman 33d Annual. Chattanooga, Tenn.: The Tradesman Publishing Co. Cloth; 6x9¼ in.; pp. 447. $5, including annual subscription to "The Tradesman."

This is a trade directory of mercantile and manufacturing concerns in the states generally known as the Southern States, together with some information regarding productions of various crops, the value of mineral products and elements of population of these states.

Machine Design

Reviewed by JOHN J. FLATHER*

MACHINE DESIGN—Hoists, Derricks, Cranes. By H. D. Hess, M. E., Professor of Machine Design, Sibley College, Cornell University, M. Am. Soc. M. E. Philadelphia and London: J. B. Lippincott Co. Cloth; 6x9½ in.; pp. vi + 368; 18 plates and 318 text figures. $5, net.

The practitioner, as well as the teacher of advanced machine design, will welcome this new book which, although written with especial reference to the needs of the technical student, will meet with much favor in the drafting room where a general field of machine design is covered. At the same time it must necessarily appeal to those who are directly engaged in the design and manufacture of this class of machinery.

The examples illustrating the text have been drawn from present-day American practise, a feature which will undoubtedly be appreciated by the student who has heretofore obtained his knowledge of the mechanics of hoisting machinery from Weisbach.

The treatment is logical and simple. It is shown that the stresses both in the frames and machinery may readily be determined by elementary principles and the design thus easily carried out on a theoretical, rather than on an empirical basis, although empirical formulas are employed where the conditions warrant it. One of the greatest difficulties in the study of machine design is the lack of knowledge on the part of the student as to the method of procedure. No matter how much valuable information is available, the student or draftsman cannot make use of it unless he has developed a plan of systematic design which will enable him to correctly co-relate his forces and materials. The method of presentation in the work under review shows that Prof. Hess has a complete understanding and full appreciation of the difficulties. His analytical treatment of the various problems discussed and theoretical deductions therefrom, modified by the requirements of practise, must appeal to everyone who has occasion to make use of the work.

The book is divided into twelve parts with captions as follows: Introduction; Frames and Girders; Brakes and Clutches; Winches and Hoists; Pillar Cranes; Jib Cranes; Under-braced Jib Crane; Inverted Post Crane; Wall Crane; Overhead Electric Traveling Cranes; Hoisting Engines; Locomotive Cranes.

The introduction includes a discussion of the properties of materials and fiber stresses used in this class of machine design; this is followed by a brief presentation of the rules of practise in the design of various machine elements including springs, belts, pulleys, gearing of various kinds, ratchet wheels, shafting, keys, couplings, bearings, wire rope, chains, drums, crane hooks, and other details.

The elements of graphic statics are concisely presented and this is followed by a discussion of rolling and sliding friction, crane blocks and block efficiencies for chains and wire ropes. Structural members and rivets conclude this portion of the work.

Part II is devoted to a similar presentation of the rules of practise as they relate to columns and beams, and to the methods of determining the stresses in frames for hoists and cranes of various forms. In this and the work which follows practical data are assumed and the problem is worked out in detail, both analytical and graphical methods being used.

Part III, on brakes and clutches, constitutes a valuable and interesting part of the book. Amongst the various forms of friction brakes discussed are block brakes, band brakes, cone brakes, multiple disk brakes, and coil brakes, all of which are used more or less in this class of machinery. Friction clutches of various types are also described and formulas are presented for their design.

The remaining portion of the book (about one-half) is devoted to the topics enumerated under the captions previously given. In each case suitable data are selected and the problem is worked out in detail. The part devoted to electric overhead traveling cranes is to be especially commended. Very complete data relating to electric cranes are here given which include crane speeds, crane tests, crane motors and wiring. The work is very fully illustrated, which greatly increases its value, but it is to be regretted that discrepancies between figures and text are not wanting. As a book of reference for the designing engineer, this work will find a well merited place: as a text for work in machine design it more than justifies its *raison d'etre*.

*Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn.

ELEMENTARY PRINCIPLES OF REINFORCED CONCRETE CONSTRUCTION—Vol. I of the Broadway Series of Engineering Handbooks. A Text book for the Use of Students, Engineers, Architects and Builders. By Ewart S. Andrews, B.Sc.; Lecturer in Theory and Design of Structures at Goldsmiths' College, New Cross; Formerly Demonstrator and Lecturer in the Engineering Department of University College, London; Author of "Theory and Design of Structures." London: Scott, Greenwood & Son. Cloth; 4½x7¼ in.; pp. 195; 57 text figures. $1.25, net.

This little book is just what one would expect from its title. It contains nothing radical or new, except perhaps a graphical treatment of the stresses in a reinforced-concrete beam and that is hardly of much practical value. On the whole the book is a very good elementary British discussion of reinforced-concrete *design*. The word *construction* in the title is too extensive.

Errors in Surveying

REVIEWED BY CHARLES L. CRANDALL*

THE EFFECTS OF ERRORS IN SURVEYING—By Henry Briggs, M. Sc., Honours Associate of the Royal Schools of Mines; M. Inst. Mining Engrs.; F. Geological Society; Head of Mining Dept., Heriot Watt College, Edinburgh. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 5x8 in.; pp. xi + 179; 23 illustrations in text. $1.75, net.

It is stated that this book is chiefly addressed to surveyors whose practical experience is such as will allow them to make fullest use of the methods of analysis developed. Everyday practice with small instruments is dealt with, rather than geodetic surveying, in order to render the greatest service to civil and mining engineers.

In Chapter II some of the fundamental principles and formulas of least squares are stated, including the propagation of error to a function of observed quantities. The latter is extended to vector errors, which are defined as independent errors influencing the position of the same point, but acting in different directions.

In Chapter III the best shape of triangles is determined for different required parts, as angles and areas, as well as sides, and extension is made to the Weisbach triangle (transfer of alignment down a shaft and into a mine) in the general case where linear and angular measurements are necessary, due to inability to set up on the extension of the line fixed by the plumb bobs.

For triangulation, the assumption is made that both of the unknown sides are of equal importance and it is found that for the best shaped triangle the angles adjacent the known side should be 56° 15′. The statement that every textbook tells us that the equilateral triangle is the best without reference to purpose, is hardly true of those which use strength of figure between base lines as the criterion as developed by the Coast and Geodetic Survey.

In Chapter IV the propagation of error in traversing is developed, considering errors of eccentricity in setting up, errors of sighting and reading and errors in linear measurement. The formulas lead to the conclusion that in compass traversing between two terminals numerous short lines give greater accuracy than a few long ones; and that in theodolite traversing a straight traverse will be less accurate than any other traverse with the same number and length of lines.

In illustrating the formulas for a straight traverse 1000 ft. long with the average error in a compass bearing of ⅛° and in a traverse theodolite angle of 12″, the accuracy would be the same for distances of 23 ft., the compass being more accurate for shorter lines and the theodolite for longer ones. This distance would increase with the total length of the traverse. The reader is cautioned against accepting this as being generally correct, but only as an illustration of the formulas for the constants assumed.

It is stated that the formula derived for the average total error at the end of the theodolite traverse allows of a valuation being made of the final error which might reasonably be expected whether closed or open, with no hint at the theoretical reduction in the average total error, or the practical value, of the closed as compared with the open traverse.

In Chapter V the relative average error due to linear and to angle measurement is discussed with reference to closure error and with reference to a line joining any two points of the traverse which may be used as the center line for a road underground by transferring the points and alinement down shafts and excavating from one shaft toward the other. The propagation of error in minor triangulation is taken up in Chapter VI.

The book should be helpful to the class of surveyors to whom it is chiefly addressed as it will aid them in becoming efficient by securing the greatest accuracy possible for a given expenditure, or in securing a required specified limit of accuracy for the least expenditure. It is quite probable, however, that a lack of familiarity with and appreciation of the value of the fundamental principles of least squares will deter more surveyors from making fullest use of the methods of analysis developed than lack of practical experience, but the summary of results in Chapter VII brings out many of the methods and special features developed clearly enough so that they can be used without a thorough knowledge of least squares.

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Copper

Reviewed by STUART CROASDALE*

THE HYDROMETALLURGY OF COPPER—By William E. Greenawalt, C. E., B. S. Part I: Roasting. Part II: Hydrometallurgical Process. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. x + 504; 112 text figures. $5, net.

This book comes before the public at a very opportune moment. While the leaching of copper ore is not new, this branch of metallurgy has never been so seriously and universally considered by the large copper companies as it is at the present time.

The treatment of ore is much like the treatment of disease. If a case is properly diagnosed and the surroundings made sanitary, almost any doctor and nurse with ordinary intelligence, can conduct the patient back to health, but the most skillful physician may have trouble in removing corns with headache medicine.

A very important step in any leaching process, whether it be for gold, silver or copper, is the study and preparation of the ore, and many failures may be traced to the neglect of both.

Mr. Greenawalt, therefore, very wisely devotes the first third of his book to this subject. It is unfortunate that there is almost no information obtainable from working plants on the hydrometallurgy of copper, for the simple reason that with one or two exceptions there are no plants of importance in operation. If leaching is to become an established branch of copper metallurgy it will necessarily be confined to low-grade ores, slimes and tailings, which, if they contain sulphur, will be low in sulphur contents; or if it be applied to a copper-bearing iron pyrite, in most instances it will be found advantageous to remove the bulk of the sulphur by a preliminary roast, and treat the calcines, containing from 2 to 5% sulphur, as a low-grade ore.

The best data available on the crushing and roasting of such ores on a large scale is found in the mills treating Cripple Creek gold ores, which contain between 2 and 3% sulphur and are roasted to approximately 0.05% sulphur as sulphide. This data applies equally well on copper ores that have to be roasted before leaching and it has been utilized to a large extent in this book.

If any criticism is to be made on Part I, it is that more space is given to laboratory experiments and antiquated roasting furnaces than is justified in a work of this kind. The metallurgy of copper has risen to the dignity of the metallurgy of iron and steel and will always be conducted on a large scale no matter how isolated the mines may be. Hand-rabbled roasting furnaces become at once impracticable and these with some of the older mechanical types should receive only passing attention.

The second part of the book contains detailed descriptions of the various leaching processes, followed by a chapter on copper precipitants and eighty pages on electrolytic processes. The latter are instructive and might be included with the copper precipitants. The problem of a cheap and satisfactory precipitant is often the most troublesome one in the hydrometallurgy of copper and it frequently proves to be the stumbling block between profit and loss.

The book closes with chapters on apparatus and appliances, power and cost data, which are important and useful.

Mr. Greenwalt's work is much needed and deserves a place among the metallurgical classics we already have on copper, lead and zinc. It is well arranged and written in a clear and concise manner. The second edition will probably be "revised downward" and it is to be hoped that this branch of metallurgy will then

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have advanced to a point where the history of working plants may be recorded instead of a description of experimental plants and patented processes.

The Design of Propellers

Reviewed by D. W. TAYLOR*

PROPELLERS—By Cecil H. Peabody, Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5⅞x9 in.; pp. 135; numerous tables. $1.25.

This book, by the author of a well known manual of naval architecture, amplifies the matter in the latter which deals with the question of propeller design. The design of a propeller being largely affected by the power which it is required to absorb, we find 33 of the 132 pages devoted to the question of the power which a given ship will require for a given speed.

The author gives four methods of estimating power, and points out that all of them, even the old Admiralty coefficient method, are based upon the Law of Comparison, either explicitly or implicitly.

When taking up screw propellers, the nomenclature of the subject, methods of delineation, etc., are first gone into. The author, although pointing out that within rather wide limits the contour of the blade has little effect upon efficiency, proposes for convenience a standard blade whose projection is an ellipse except close to the hub.

The methods for determining diameter, pitch, revolutions, etc., of propellers are all based upon the Law of Comparison. Published experiments with model propellers, primarily those made at the United States Experimental Basin in Washington, which agree with those by Mr. Froude at the Admiralty Model Basin, in England, have been analyzed and the results reduced to tabular form, elaborate tables applicable to all sizes of propellers being given. The Law of Comparison, connecting models and full-sized objects, is relied upon throughout, although here and there the author rather casts reflections upon its accuracy. By use of the numerous tables given the revolutions of a propeller, the power absorbed by it, and its speed of advance through the water, the diameter, slip, pitch, etc., can be determined.

The speed of advance is not the speed of the ship through still water, but the speed of the propeller relative to the disturbed water at the stern in which it works; hence it is necessary to know or estimate not only the speed of the ship, but the wake factor. The author gives such information as is known concerning the latter, which is not very complete.

With respect to cavitation, which has been a troublesome question for some years past, there is little given that is new. Recent experience has shown that Barnaby's and Speakman's recommendations in this connection are not always applicable.

The most unfavorable criticism that can be made of this excellent work is that it is too short, the space given to many subjects being insufficient to cover them as thoroughly as if the author had not evidently determined to make a short book. Of minor criticisms and typographical errors the following may be noted: The author seems to prefer to use the expression "residual resistance" to denote the sum of the resistances other than frictional, instead of "residuary resistance," the usual expression first adopted, it is believed, by the elder Froude.

On page 22, in connection with independent estimates of power, it is stated that a certain coefficient *b* can be found on pages 17 and 18. There seems to be nothing given as to suitable values of *b* on pages 17 or 18, or anywhere else, and on page 25, a value of *b* is used without explanation.

There are a few typographical errors, such as "two-rope" and "steam-line" on page 16 instead of "tow-rope" and "stream-line," and on page 101 "extimate" instead of "estimate."

For its purpose, namely, the design of propellers, the tables are naturally the most valuable part of the book. They appear to be excellently adapted for the purpose and should be very useful to those who have to deal with propeller design.

The general treatment of his subject by the author is undoubtedly the best and most scientific and is now generally accepted as such, the prejudices against conclusions drawn from model experiments having well nigh disappeared from the minds of present-day naval architects and marine engineers.

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Hydraulics in Simple Form

THE PRIMER OF HYDRAULICS—By Frederick A. Smith, Hydraulic Engineer; Asst. Engr., Dept. Public Works, Chicago, Ill. Chicago, Ill.: D. H. Anderson. Cloth; 6½x7¾ in.; pp. vi+217; 110 text figures; 22 tables. $2.50, net; flexible leather, $3.50, net.

Reviewed by JOHN H. GREGORY*

In the "Primer of Hydraulics," consisting of 22 articles and 207 pages, the author has presented much information which will be of service not only to a beginner first taking up the study of hydraulics but also to the practicing engineer. In the first eight chapters, or articles as they are designated in the book, the author, in simple language, takes up the General Properties of Matter, Algebraic Principles, Geometrical Principles, Trigonometry, Mensuration of Plane Figures, Mensuration of Solids, The Principles of Mechanical Forces and The Three States of Matter.

In the following article General Hydraulic Principles are discussed and the well known Kutter formula for computing the flow of water is presented. The author lays special stress on a new form of channel, which he terms a composite section, especially adapted to accommodate a small dry-weather flow and a considerable flow of storm water. The lower part of the section is formed by two lines at right angles to each other, each line being inclined at an angle of 45 degrees to the horizontal. The upper part of the section is formed by a circle, the two lines forming the lower part of the section being tangent to the circle below the horizontal diameter. A somewhat similar section is considered in the "Taschenbuch für Kanalisations-Ingenieure," by Dr.-Ing. Karl Imhoff (Essen, Germany, 1907), except that the lines forming the lower part of the section are inclined at less than 45 degrees to the horizontal and the upper part of the section is square or rectangular.

Three articles are devoted to The Coefficient of Roughness, How to Calculate "*n*," and Explanation of "*C*" Tables.

The following seven articles take up and work out the solution of problems involving Open Channels, Closed Channels, Pipes Flowing Full under Pressure, Loss of Head by Enlargement of Channel, Subdivision of Channels, Loss of Head at Entrance to Pipes, and Ditch Tables and Their Application. The last two articles are devoted to Flow Measurements and the Use of Logarithms.

The book ends with a series of useful tables. In the first thirteen tables are given values of *c* in Kutter's formula for various values of *n*, $\sqrt{r}$ and *s*, followed by tables of numbers and their square roots, used principally for *r* and *s*. Two tables are devoted to giving the hydraulic elements of circular and composite sections partly filled. The remaining tables include Areas and Circumferences of Circles, Hydraulic Equivalents, Weights of Various Substances, Metric Conversion Tables, a table for converting the flow of water from one unit to another, a table for determining the size of circular conduits with given velocities and volumes of discharge, and tables of Squares, Cubes, Square and Cube Roots, Logarithms and Natural Sines, Cosines, Tangents and Cotangents. Of the tables given those relating to hydraulics are of the most value, especially the tables giving the value of *c*.

The book would be materially increased in value by the addition of diagrams for the use of the many engineers who prefer to read directly the corresponding size, slope, velocity and discharge instead of having to compute the

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same, even with the assistance of conveniently arranged tables.

One or two errors have been noted in one of the tables, but it is recognized that some errors are almost sure to occur in the first edition of any book. It is to be hoped that, with a second edition of the book, the author will see fit to adopt the size of page so widely used in the numerous engineering handbooks and also to bind the book in a similar manner, changes which could be readily made and which would not involve any resetting of the type.

Railway Transportation

Reviewed by CHARLES HANSEL*

RAILWAY TRANSPORTATION—A History of its Economics and of its Relation to the State. Based, with the author's permission, upon President Hadley's "Railroad Transportation: Its History and Its Laws." By Charles Lee Raper, Professor of Economics, Dean of the Graduate School, University of North Carolina; Author of "The Principles of Wealth and Welfare," etc. New York and London: G. P. Putnam's Sons. Cloth; 5¼x8 in.; pp. xi + 31. $1.50, net.

Dr. Raper has given us a searching review of the conditions and results of railway operation, together with the guiding theories which have influenced the several countries in determining their attitude toward this world-wide problem of transportation. His book is especially recommended to the many who, while thinking they know, actually know nothing of the question.

The author devotes much attention to rates of carriage. This is of value in studying conditions which prevail in each country. It is not clear, however, that the statistics given should be used to make comparisons of the cost of railway service in different countries, for the reason that we are not given the purchasing power of money, nor the precise conditions of the service, nor the cost to the railways to perform a given service.

The author sums up his conclusions regarding private versus governmental operation of railways (page 304), and closes with the following:

> The institution of government operation in such countries as the United States and Great Britain, with their present systems of comparatively efficient operation under relatively effective state control, could have no possible defense except that of political and social ambition—the ambition of the state to become wider, greater and more powerful in all phases of the life of the people, to perform services which private enterprise under state supervision could perform just as well, and perhaps much more efficiently. Its only possible defense would be socialism.

The analysis of conditions attendant upon railway transportation in this, and other countries, as set out by the author, has been accomplished with such fidelity and clearness as to make his book of great value to all who are seeking light on railway transportation.

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Railway Freight Traffic and How It Is Handled

FREIGHT TERMINALS AND TRAINS—Including a Revision of Yards and Terminals. By John A. Droege, Superintendent, Providence Division, N. Y., N. H. & H. R.R. Co. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. vii + 465; 208 text figures. $5, net.

In spite of the importance of the subject of railway operation, very little has been written upon its practical side, although it has been discussed more extensively from the economic and statistical points of view, largely by men outside of the railway service. When Mr. Droege published his book on "Yards and Terminals," six years ago,* he produced a work of very direct value and interest to the railway officer (in whatever department of the service). The same may be said of the present book, which is not a revised edition, but is practically a new book. It covers a somewhat wider field, it goes more deeply into detail with matters of design and operation, and it presents a much greater amount of information relative to the conditions and designs of individual plants. As a railway officer of many years' experience the author has an intimate understanding of his subject, and he has broadened this knowledge by study of matter beyond his own experience. In addition, he has the facility of writing clearly and concisely. A very short acquaintance with the book suffices to show that the author has an analytical and critical mind, as well as a thorough grasp of his subject. His criticisms and critical views are distinctly of a constructive or helpful character, and he mentions certain improved methods suggested and introduced by him.

The general subject of railway freight terminals and terminal work is dealt with in two chapters on "The Terminal Problem," and "General Requirements of Terminal Design." A few statistical figures show the importance of the railway freight business as a whole, but of greater importance are the references to actual and governing conditions at different points or localities. Mention is made of the Chicago freight-subway system, with about 65 miles of narrow-gage electric lines in low-level tunnels connecting various freight stations, warehouses, wholesale establishments, etc.; but unfortunately nothing is said as to the operation or traffic of this unique system of collecting and distributing freight in a large city.

Two important features which are explained are: 1, the cost involved in unnecessary stopping of trains, as in the case of defective or inadequate facilities at yard entrances; 2, the great loss of economy involved in keeping cars standing idle for a large proportion of the time in their passage from starting point to destination. Records show an average run per car per day of only 23.7 miles (the car being in actual movement for only 10% of the time), while the average load per car is less than 20 tons or only 55% of the capacity. Further, a car may spend 18 hours or more in each terminal yard through which it passes. Since these are average every-day conditions, it is evident that in order to obtain more economical operation there is need for better methods and facilities to insure a greater average load per car, a greater mileage per car, and less delay to cars both in movement on the road and in loading and unloading. It will not suffice to see to the improvement of efficiency in the individual yards and terminals; but equal attention must be given to coordinating their work with a view to the economical operation of the freight business as what we might term a multiple unit.

*This was reviewed in our issue of June 14, 1906.

The ideas expressed by the late A. M. Wellington as to the economics of railway operation are quoted and indorsed and the author quotes from ENGINEERING NEWS (Mar. 3, 1910) an analysis of the relation of cost of freight movement along the road and through terminals. Although no two terminals can be constructed alike, and the layout in each case is governed largely by local conditions, yet there are general principles which apply with greater or less force in every case. Furthermore, one terminal may present features or innovations which may be applied to advantage at other terminals. For these reasons, both the general discussions and the individual descriptions in the book have their respective values to the reader.

It is shown that yard improvement does not mean necessarily enlargement or extension; in fact, unsystematic extension may be detrimental to efficiency, and in certain cases a reduction in size or subdivision into separate units may be found effective. In the discussion of terminal and yard design and certain other matters, the author quotes liberally from the reports of the Yard and Terminal Committee of the American Railway Engineering Association. A special chapter on "Track Construction and Maintenance" (written by Prof. Charles B. Breed, Massachusetts Institute of Technology) is of greater scope and importance than its title implies; it relates largely to such matters as track plans and layouts of sidings and yards, yard lighting, switches and turnouts, and clearing snow from switches.

Yard work is dealt with mainly in connection with classification yards. The "hump yard" for gravity switching has been developed and adopted very extensively in recent years, and the advantages of this system are explained; numerous examples of such yards are described and

illustrated, especially in regard to the grades and profile of the hump. Nevertheless, the author is of opinion that there is much to be said in favor of pole switching, especially where this is supplemented by gravity (through assisting grades) to facilitate the movements of cars. A difficulty with gravity yards is the selection and maintenance of the rate of grade most suitable to the operation in each individual yard and at different times of the year. In one case a concrete foundation is used, so that the summit of the hump will not settle or be depressed by the effects of traffic, which would reduce the rate of the steep grade which starts the cars on the downward run. The same yard has an adjustable starting grade, adjusted by jack screws placed permanently under the track, so that it can be made steeper in winter when the cars ride less easily.

While gravity switching is used extensively, the author considers that poling must generally be taken into account as an auxiliary to it, for the reason that except in a mild climate it is hardly practicable to construct a purely gravity yard that can be successfully operated as such throughout the year and under all conditions of cars, loads and weather. And as a rule the gravity yard is not economically practicable unless the topography is adapted to its construction. However, some large hump yards have been built on level ground.

The ordinary "push-and-pull" method of switching, in which the engine is coupled to or butted against each cut of cars moved, is considered to be slow, expensive in operation and the cause of much damage to cars. The disadvantages increase with the size of the engines used. In small yards and crowded city yards it may be the only practicable method, but for larger terminals the author considers that it should be eliminated as rapidly as possible. There are, however, many large yards operated on this system. The power operation of yard switches is mentioned, as is also the use of electric lights, but the important matter of yard lighting for night work is not discussed to any extent. As to yard work, the author mentions a method introduced by him in which the use of a relief or relay engine enables the regular switching engines to be sent off for coal, water or light repairs without interfering with the yard work.

The chapter on "Operation of Yards" is of special interest, since there is so little literature on the subject. It is accomplished by a table of operating results for a number of yards. This gives the cost at 5 to 32c. per car handled, but it is pointed out that the figures of cost are very approximate. Records and statistics of yard work seem to present a hopelessly complicated system, unless the reader bears in mind that the work is performed much more easily than it can be described. Even so, it is a difficult and complicated matter to keep track of the movements of innumerable cars through a yard and from place to place as they proceed toward their destinations. Such records are essential, however, to efficient and economical operation of the yard or terminal itself and of the freight business as a whole. The book describes different systems of records in sufficient detail to explain their purpose and their use. Systems in regular use are likely to develop undesirable "red-tape" characteristics or accessories, and such systems need to be overhauled occasionally with a view to simplifying or eliminating such reports or records as may be found complicated or unnecessary or which can be dispensed with. As a matter of fact, too many reports are drafted largely with a view to getting as much information as possible rather than getting only significant items of information; and many reports and forms continue in use simply because they have become established, and nobody has undertaken to review them critically with a view to their practical value. Reports required of train men and yard men should be as simple as possible, but even this very obvious fact is frequently ignored.

The complicated subject of the business of handling freight is dealt with in several chapters, and in a very thorough manner. From pointing out the importance of this part of the railway service, its cost, and its relation to railway operation, the author proceeds to a discussion of freight houses and freight handling. A number of freight houses and warehouses are described in brief, but we think a little more might have been said as to the way in which they are used, or in explaining the significant features in each case. Transfer stations, where freight for certain points is consolidated from several separate carloads to one through car; or distributed into cars for local service, are discussed in a separate chapter which deals with the details of operation rather than with the design or construction. In close relation to this general subject are the chapters on the operation of freight houses, the work and duties of the freight agent, loading cars, making up trains, fast-freight service, etc. But for the realization of the fact that the description is necessarily more complicated than the actual performance, the reader might well wonder how the work ever gets done, and how its intricacies ever get carried out by ordinary everyday men in the stress and rush of everyday work.

The special subject of refrigerating, heating and cooling for perishable freight, both in cars and at terminals, is covered in a separate chapter. It includes precooling plants for cooling cars of fruit, etc., before shipment, car-icing plants, refrigerating cars and the packing and inspection of perishable freight. Another chapter deals with the live-stock business, which is another special branch of the freight business.

The chapter on "Weighing Freight" covers the weighing of cars on track scales (in the yards and on switching humps), wagons on platform scales, and freight packages on house scales. Both the apparatus and the methods are described, together with such important matters as the variations in weight of loads and cars in relation to accuracy of results in fairness to both the railway and the shipper. Automatic recorders for track scales and automatic weighing hoppers for coal are mentioned. Questions of locomotive capacity and the tonnage rating of trains are discussed in the chapter on "Making up Trains." The loading for the engines may be based on three distinct ideas: 1, to move the maximum tonnage consistent with speed requirements; 2, to move the maximum tonnage per day for a long period of time; 3, to move the tonnage at a minimum cost per ton-mile. The use of pusher engines and double-header trains enters into these considerations.

The mechanical handling of freight is a special subject of growing importance, and to this 24 pages are assigned, independent of certain references to the equipment at team yards, water-front terminals, etc. The mere handling is a comparatively simple matter. As applied to freight-house work, the great difficulty lies in obtaining sufficient flexibility of movement, since freight at any one of the doors of the house or any one of the cars in the house may have to be delivered to almost any car or door respectively, while the packages to be handled are of infinite variety in shape, size and weight. To equal the flexibility of the hand-truck system under such conditions is no easy matter. The systems mentioned are as follows: 1, conveyors (roller, chain, belt, platform, etc.); 2, overhead traveling cranes; 3, carrier systems (telferage); 4, small motor trucks (in place of hand trucks). Conveyors are of two classes; those which carry the freight packages direct, and those which carry the hand trucks. The latter are used to advantage at steamer piers to facilitate movements on inclines when the deck and pier floor are at different elevations; they have been proposed also for freight houses. Where a particular class of freight is to be handled between definite points (such as sacks, bales, or barrels between a dock and a shed or warehouse), freight conveyors may be applied with advantage. The telferage system is described as applied to a steamship pier at Richmond and to a general freight house at St. Louis, the routes or movements being direct in the former and complicated or varied in the latter. The electric motor-truck system is the most flexible, as the trucks are not limited to any fixed routes or permanent plant. Details are given

of the work and cost of freight handling by electric trucks handling average loads of 1000 to 1600 lb.

Special classes of terminal facilities which are discussed in separate chapters (aggregating 60 pages) may be grouped as follows: 1, Water-front terminals; 2, team yards; 3, coal and ore docks and, 4, grain elevators. The chapter on "Water Front Terminals" deals with steamship piers and their accessories, and describes briefly the features and equipment of several large terminals of this kind at ocean ports. It discusses also the movement of freight by lighters and car ferries. The matter of ports on inland waterways is not touched. For team-delivery yards, the track layout is governed usually by the site available, and a number of examples are illustrated. Stub tracks in pairs are recommended, with a maximum capacity of 12 to 15 cars. The paving, crane equipment, track and wagon scales, etc., are dealt with.

In the two chapters on coal and ore docks, some large modern coal piers are described, and there is a list of dimensions of a number of such piers. Unloading and car-dumping machines are described, as well as mechanical apparatus for handling coal at storage plants. Some information is given also as to the deterioration and heating of coal in large stock piles. The chapter on ore docks deals mainly with machines for unloading vessels, and has little or nothing in regard to ore-shipping docks. This seems strange in view of the importance of the ore traffic and the development of special facilities for handling it. Although a chapter is headed "ore and lumber docks," lumber is mentioned only incidentally. Grain elevators are dealt with in a chapter which describes at some length the operation of the grain business and the handling of the traffic, besides describing several individual elevators. The author suggests that the whole question of grain handling may undergo a radical change due to the impending necessity of importing instead of exporting grain. He states that in view of this condition and the probable importation of grain for home consumption by 1920, the New York Central R.R. has deferred the building of new elevators at Buffalo. A rather surprising feature of this section of the book is that practically nothing is said as to the terminal and track arrangements for serving coal and ore piers and grain elevators.

Engine terminals and their facilities are dealt with in four chapters covering 65 pages. No doubt this subject should be included, but as there is much more information published elsewhere in regard to it than to freight-traffic facilities and operation, we should have preferred to see this more condensed and the space given to matters more directly pertinent. The chapters deal with engine houses, engine-coaling plants, ash and sand plants, and the engine-house foreman. As to engine houses of rectangular and segmental (or circular) shape, the author favors the former, although it is used to a very limited extent in this country. He classifies the former rather unscientifially as "square" and "rectangular," the tracks of the "square" house being served by a ladder track and switches, and those of the "rectangular" house by transfer tables. It is the first of these arrangements which he prefers. The distinction is important, but the nomenclature is decidedly unfortunate, and the so called "square" house illustrated is not square in shape.

The liability of excessive loss of engine service at terminals is mentioned, and a record is quoted showing that an engine spent 22% of its time at the terminal (for repairs, coaling, delays, etc.), and 29% in actual running, while various delays on the road consumed the remaining 49%. Among the several terminals illustrated is one having an oval "roundhouse" with 70 stalls in two groups served by two turntables placed side by side in the inclosed space. The chapter on coaling plants deals with both the storage and handling of coal, and gives lists of approximate cost of handling by different methods. Most of the plants described are for accommodating large numbers of engines. The necessity of well arranged and well equipped ash-handling plants is explained and several arrangements are described. The author suggests running the engines on a track elevated sufficiently to enable the ashes to be dumped directly into steel cars, thus avoiding all shoveling.

The author takes occasion to point out the lack of economy and poor management in failure to provide equipment adequate to the work required. Thus in regard to engine terminals he instances one coaling plant which needed piping for thawing coal in cars and hoppers, and another operated by hand shoveling in spite of the arguments of the officers for a proper mechanical equipment. The former plant required during the winter a force of 10 or 20 men to loosen frozen coal. The author estimates that the "saving" of $500 for a permanent improvement in the first case and $4500 in the second case cost the railways about $2500 per winter in each case. Probably the responsible executive officer reasoned (if he reasoned at all) that hand labor was cheap, and he failed to realize the high aggregate cost of this continued labor cost, to say nothing of the additional cost of engine service due to the inadequate facilities in the second case.

An interesting chapter on "British Freight Service" (by Prof. Wm. J. Cunningham, Harvard University) points out the fundamental difference between English and American practice. English railways handle small shipments rapidly, and a large proportion of their freight traffic is closely comparable to the service of American express companies. The American railway handles larger average shipments in larger cars and with far less rapidity. Furthermore, English railways do most of the collection and delivery of freight, while American railways handle it only from station to station, so that the handling of the freight between its points of initiation and destination is divided between shipper, railway and consignee.

The chapter on "Management and Discipline" applies to railway operation in general and relates only incidentally to terminal work. But in view of the importance of the subject at this time, and of the fact that the book will be used by officers whose duties are much broader than (though inclusive of) terminal operations, this chapter may be considered as highly appropriate. The departmental, divisional and unit systems of organization are explained, but the author deals rather with the broad and general aspect of the question of securing efficiency, economy and safety in railway service by proper action on the part of both officers and employees. The relations between these two elements in matters of discipline are discussed at some length. The author points out that the men are scattered and most of them are not under the direct supervision of any officer. They should be impressed with an understanding of their responsibilities and the importance of performing their duties faithfully and thoroughly, and also with the feeling that their officers have confidence in them. But having and showing confidence does not imply absence or neglect of supervision. In fact, the author says plainly that there cannot be too much of honest, open and intelligent supervision, which in turn carries with it the constant education of employees.

The book is well written, and the author is at his best when discussing methods and principles rather than in describing the details of buildings and plants. The illustrations are thoroughly good, and special commendation should be given for the clearness and good lettering of the line cuts. In fact the mechanical work of the book is of a high class throughout.

MATERIALS AND CONSTRUCTION—A Textbook of Elementary Structural Design. By James A. Pratt, Mech. E., Director of the Williamson Free School of Mechanical Trades; M. Am. Soc. M. E. Philadelphia, Penn.: P. Blakiston's Son & Co. Cloth; 5x7 in.; pp. xi + 196; 85 text figures. 90c. net.

This book is an elementary presentation of the subject of materials intended for the use of trade-school students. In correctness of statement coupled with simplicity of language it is admirably adapted for that purpose. Not only are descriptions of the properties of the various structural materials given, but a simple treatment of the theory of structural design as well.

DIESEL ENGINES FOR LAND AND MARINE WORK—By A. P. Chalkley, B. Sc., A. M. Inst. C. E., A. I. E. E. With an Introductory Chapter by Dr. Rudolph Diesel. New York: D. Van Nostrand Co. Cloth; 5½x8¾ in.; pp. viii + 226; 82 text figures. $3, net.

This book is the American issue of an English book published in London a few months ago. The introductory chapter by Dr. Diesel is in substance an excerpt from his address delivered last spring before the British Institution of Mechanical Engineers and the American Society of Mechanical Engineers.

The book appears to have been made up for the most part from information gathered from the articles on the Diesel engine published during the last two or three years in the principal European engineering journals. There is unquestionably a very wide interest in and desire for information upon the Diesel engine in this country. A large proportion of those seeking this information, however, are not sufficiently familiar with thermodynamics and mathematics to gain any very clear idea from the opening chapter of this book, entitled "The General Theory of Heat Engines." Those who can follow the author's discussion will be inclined to question some of his statements, as, for example, his remark at the opening of Chapter II that the essential difference between the Diesel engine and practically all other motors burning gaseous or liquid fuel in the cylinders is that the Diesel engine is a combustion engine, while all others are strictly speaking explosion engines. Of course, one can find warrant for this sort of statement in some of the theoretical treatises on gas-engine design, but the general knowledge as to the length of time required for complete combustion in even such small-sized cylinders as those used on automobiles is sufficient demonstration to the practical mind that no hard and fast line of this sort can be drawn between the Diesel and other combustion engines. The same idea is probably responsible for the author's claim that the maximum temperatures obtained in Diesel engine cylinders are lower than those obtained in the gas engine.

The subjects discussed in the book as taken from the chapter headings are as follows: Action and working of the Diesel engine; construction, installing and running of the engine; testing of the engine; Diesel engines for marine work; future of the Diesel engine.

A large part of the book is devoted to illustrations and descriptions of some of the latest types of Diesel engines built by European manufacturers. As the book is by an English author, no reference is made to American practice (or lack of practice) in this new field of mechanical engineering.

The engineer who wishes to post himself in a general way as to what has been done with Diesel engines abroad up to about a year ago will find the book a useful guide. On the other hand, the author does not attempt to go very far into questions of detailed design, and cost figures are lacking.

The copy of Dr. Diesel's original patent specification dated Aug. 27, 1892, contained in the appendix, raises the interesting question to what extent Dr. Diesel is responsible for the design and invention of what is now known as the Diesel engine. The specification itself bears evidence that carrying the compression of air in the cylinder high enough to ignite an oil spray, delivered into the clearance space at the end of the compression stroke, which is the distinctive feature of what is now known as the Diesel engine, was known and used prior to Dr. Diesel's patent.

Central Electric Station Commercial Engineering

COMMERCIAL ENGINEERING FOR CENTRAL STATIONS—A compilation of papers dealing with subjects of particular interest to those engaged in central station commercial engineering work. By Arthur Williams, Past-President, National Electric Light Association, and Edmund F. Tweedy, Commercial Engineer. New York: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 242; 27 text illustrations. $2.50, net.

The authors have shown in this volume a few typical examples of the engineering scrutiny which should be given to each proposition to make an excursion into new fields of new central-station business. The authors' statements are conservative and the book discloses fields where few prospects are seen, as well as the reverse.

One of the chief efforts of central-station men is to secure the lighting and miscellaneous power load of large buildings which might have isolated generated plants. One of the important claims which has to be substantiated in each case is that it is economy to install special steam-heating equipment and buy central-station energy instead of generating current on the premises and using the exhaust steam for heating. An accurate estimate of the heating requirements then is one of the most frequent problems of the central-station new-business engineer, and in their first chapter the authors have disclosed their practice in this particular.

An opposite process—cooling the air in buildings—holds out to the authors the prospect of considerable development as future station load, and they outline a scheme for determining the amount of cooling required for different conditions. They say little, however, of the actual relation between cooling required and the energy or cost of operating the cooling systems, though this lack is partly made up in discussing refrigeration for fur-storage rooms and ice and ice-cream manufacture.

Evidently, the relatedness of heating and cooling studies has been considered sufficient to allow insertion of the latter, between "heating" and "cost of generating electrical energy," divisions which we might expect naturally to lie together in view of the need for central-station managers opposing the installation of isolated plants. The two chapters on energy costs are compilations of data from a number of plants.

After this comes an instructive chapter on central-station load factors—the ratio of an average load to some maximum demand. Besides giving performance data of several plants, it discusses a number of influencing conditions. Among these should be noted the effect of the newer high-efficiency incandescent lamps in (1) increasing the number of customers for the same output, and in (2) prolonging the hours of service—points which have been neglected as benefitting the central station. It is understood, of course, that everything that increases diversity of use increases the ratio of average to maximum demand, decreases the hours of idle equipment, and decreases unit overhead charges. The authors also show the desirability of securing street-railway load on account of the diversity of peaks from those of lighting demand.

After much discussion of engineering economics the authors revert to chances of future load in special fields—department stores, office-building elevators, ozone production, and sewage treatment.

The chapter on ozone generation and use is necessarily much abbreviated and this is not helped by the careless preparation of a drawing showing a Gerard machine. The authors give the impression that use of ozone may actually purify certain bad atmospheres, whereas it is a deodorizer and does not eliminate deleterious air burdens except by substituting another (CO_2). The benefit is largely psychological—though just as real, perhaps, in some cases. It is hard to see how it can truly help, as the authors say, "workmen and workwomen who are subjected to the deadening effects of bad air."

There is a long discussion of sewage purification which leads, of course, only to the conclusions that (1) electric energy is applicable so far only in the production of chemical disinfectants and precipitants, and (2) local use of current is indicated only when the unit cost is very low and freight rates on chemicals very high. It should be noted, however, that the discussion itself is not above criticism. For instance, the authors seem to have "bacterial purification" in mind rather than the removal of putrescible matter, which is the aim of present-day methods. They seem to fail fully to grasp the fact that disinfection of sewage is idle without first removing

putrescibles. The Brewster sewage disinfection plant is noted as "successful" and "still running." While the work there was fairly effective, it was not economically successful and we have reason to believe has not been carried on for some time.

A Chapter from the Public-Health History of New York City

THE CITY THAT WAS—By Stephen Smith, A. M., M. D., L. L. D., Commissioner of the Metropolitan Board of Health, 1868-1870; Commissioner of the Board of Health of New York, 1870-1875. New York: Frank Allaben. Buckram; 5½x8 in.; pp. 211; 27 text figures. $1.25, net.

The larger and by far the more valuable portion of this volume is devoted to a sanitary campaign conducted a half century ago to reclaim New York City from filth and communicable diseases that almost put the cities of the middle ages to shame. The campaign resulted in the establishment of the Metropolitan Board of Health, the first effective public-health service of New York, Brooklyn and other communities now within or adjacent to Greater New York. The author took an effective part in the campaign and subsequently was a health commissioner for the metropolitan district and still later for New York City.

Nearly two-thirds of the volume consists of an address made by the author to a joint committee of the New York legislature, which committee then had in its charge legislation designed to make possible sanitary and other health-protective reforms in New York City and vicinity. The address was largely composed of extracts from sworn reports of special medical inspectors employed by a voluntary organization to make a sanitary survey of New York City.

The portion of the book which precedes the address is in part introductory and in part anticipates the account given in the address. Following the main address is a second one by the author of the book, eulogizing the late Dorman B. Eaton, who drafted the bill which did much to bring New York out of its sanitary morass, and who for many years contributed to the uplift of that city in other ways.

The closing chapter (save for a short valedictory) is entitled "The Occult Power of Filth." The chapter aims to present the principles of modern health-protective work, as based on the germ theory of disease, and to ally those principles with the older ones which actuated the crusade against filth, before the germ theory was announced and accepted. While this chapter shows a grasp of modern public-health principles remarkable for a medical practitioner and sanitarian of the old school, it does not adequately present the vital principle of modern health-protective work, which is the control of infection at its source, rather than a campaign against various infected materials which never should have been infected.

In a small way, "The City That Was" (too vague a title for a book of its character) deserves a place with Jephson's "The Sanitary Evolution of London," noticed in our issue of Nov. 14, 1907, p. 541. The later book is only a chapter, though a large and important one, from the sanitary evolution of New York. Its value lies chiefly in the contemporary document which is reprinted (from the New York *Times* of Mar. 13, 1865). This value is somewhat increased and the interest of the book greatly enhanced, by the author's review of the events that led up to his address. It is to be hoped that time and strength will permit him to review the salient features of his work as commissioner of health for the old Metropolitan District of New York and for the City of New York.

Elements of Reinforced Concrete Design

REINFORCED-CONCRETE CONSTRUCTION—Vol. I: Fundamental Principles. Including Numerous Tables and Diagrams to Facilitate the Calculation and Design of Reinforced Concrete Structures. Prepared in the Extension Division of the University of Wisconsin, by Geo. A. Hool, S. B. Associate Professor of Structural Engineering. Engineering Education Series. New York and London: McGraw-Hill Book Co. Cloth; 6x9¼ in.; pp. x + 254; 88 text figures, 15 diagrams, 16 tables. $2.50, net.

The Extension Division of the University of Wisconsin offers, in connection with its correspondence-school work, a course on reinforced-concrete construction, for which there is being prepared a three-volume set of textbooks. Vol. I of this series, which has just been published, takes up the fundamentals of design and, according to its preface, the coming two volumes are to be devoted, respectively, to the detailed design of retaining walls and buildings, and to the detailed design of bridges and miscellaneous structures. None of the details of construction or inspection are touched upon in this first volume, though there is a possibility—not, however, indicated in the preface—that the future additions will consider something beyond design.

The treatment of the fundamentals of design in the first volume, while following the usual and rational lines adopted by the best books heretofore published on this subject, is markedly clearer and less complicated than in previous works. The three preliminary chapters on the properties of the materials, concrete, steel, and concrete and steel in combination, are followed in order by chapters on rectangular beams, slabs, cross-beams, girders, columns, bending and direct stress, and designing tables and diagrams. The preliminary chapters are reduced to the lowest terms and can hardly carry to a reader anything more than a suggestion as to the peculiarities of the materials which go to make up reinforced concrete. Obviously, they are only included to round out the subject and other books are supposed to be consulted by any one who wishes to study this most important branch of concrete construction.

On the other hand the theory of design, which is the main subject of the book, is developed in a manner most beneficial to those students who, as the preface states, are presupposed to have a knowledge of the elements of structures. Problems to be solved, added to each chapter, should help materially to the understanding of the theories and methods described.

Finally, it must be noted that the book is intended for correspondence-school study. We have no quarrel with the author's statement that he "sees no reason why a text of this nature may not be employed for other purposes," i.e., for a school-room text or for reference. In fact, we think it eminently fitted for just those purposes. It is when we come to the correspondence-school feature that we have to admit, not our doubts as to its utility for such work, but our wonder at the application, industry and almost genius of the students who can be led from ignorance of all things structural through the series published by the University to a finished capacity for structural designing. This is *not* a criticism of that series of books but an expression of admiration for the men who use them.

How United States Railroad are Financed

RAILROAD FINANCE—By Frederick A. Cleveland, Ph. D., LL.D., and Fred Wilbur Powell, A. M. New York and London: D. Appleton & Co. Cloth; 5½x8½ in.; pp. xv + 462 . $2.50, net; postpaid, $2.70.

The authors of this book have already presented a volume on a similar subject entitled "Railway Promotion and Capitalization in the United States," which was reviewed in our issue of July 15, 1909. Some of the material used in that volume has also been made use of in the first two chapters of the present book, entitled, respectively, "The Economic Basis of Railroad Investment" and "Promotion and Underwriting." The further chapter titles will give the reader a fair idea of the general scope of the book. Chapter IV is entitled "Finances of Construction," and will probably be of as great interest to engineers as any chapter in the book. The author relates here some interesting history regarding some of the famous (or infamous) construction contracts in connection with the building of the Union Pacific and other roads. Chapter V is entitled "Financing Equipment," and describes the various methods by which railways arrange for

the purchase of cars and locomotives on credit. The author describes the car-trust certificate and other methods of purchasing equipment on credit; but he does not explain why many of the strongest roads financially still continue the purchase of equipment on this plan. Railways have accumulated a large surplus and invested it in stocks and bonds of other railways and in various outside enterprises while still continuing to buy their cars and locomotives on credit. It would be interesting to know whether such a system of financing rolling-stock equipment prevails in any other country of the world.

The five or six chapters following are devoted chiefly to the financial organization and management of the company, including the methods of accounting. These chapters contain much material that should be very valuable for reference. Chapters XII, XIII and XIV are devoted to "Insolvency," "Receivership" and "Reorganization," respectively. Chapters XV and XVI are both devoted to the subject of consolidation and have much historical interest for their record of important consolidations which have taken place in the past. The last chapter of the book relates to the subject of over-capitalizations and the book concludes with a very complete bibliography occupying no less than 75 pages, while the index to the present volume is 33 pages in length. This long chapter on "Bibliography" is practically a catalog of all the important books which have been published on railway finance.

RAILROAD OPERATING COSTS—A Continuation of Studies in Operating Costs of the Leading American Railroads. Arranged to include the operations of 1911. By Suffern & Son. Volume II. New York: Suffern & son. Cloth; 8x11 in.; pp. 144; 64 text figures. $2, net.

The title to this book is misleading, or rather it is not enlightening. In fact, however, it would not be easy to give a short title defining the scope of the work. It is an analysis of railway statistics and particularly statistics regarding railway operating expenses which aims to bring out the lessons regarding possible economies, etc., which such statistics, properly interpreted, should teach. In examining the tables and diagrams in the book, one is reminded, indeed, of some of the valuable matter collected and presented a quarter century ago by the late A. M. Wellington in his "Economic Theory of Railway Location."

Chapter I is devoted to the analysis of general statistics given in the Interstate Commerce Commission reports, such as capitalization per mile, gross earnings per mile, population per mile, density of traffic per mile, and per cent. of operating expenses to gross earnings. An interesting feature of this chapter is a series of profiles of some of the most important trunk-line railways and main-line railways west of Chicago.

In the chapters following, the various subjects taken up are: "Maintenance of Way and Structures," "Maintenance of Equipment," "Freight Car Maintenance," "Locomotive Maintenance," "Passenger Car Maintenance," "Transportation Expense" and "Fuel." One defect in the comparisons and figures given in the book is the lack of full knowledge concerning the local conditions which may have caused a discrepancy to which attention is directed. The authors of the book are in fact a firm of accountants. For a critical analysis in detail of the operations of any particular road, or its comparison with results on another road, an intimate knowledge of all the circumstances of the two roads would need to be acquired, which was apparently not available to the authors of this book.

A capital defect in the book is the lack of any index whatever, save a rather profuse table of contents. Those who will use such a book will do so chiefly as a book of reference and it is surprising that a thorough index guide to its contents should not have been included between its covers.

On Grinding

Reviewed by WILLIAM W. BIRD*

AMERICAN MACHINIST GRINDING BOOK—Modern Machines and Appliances, Methods and Results. By Fred H. Colvin and Frank A. Stanley, Associate Editors "American Machinist," Members A. S. M. E. New York and London: McGraw-Hill Book Co. Cloth; 6x9¼ in.; pp. ix + 383; 286 illustrations; 36 tables. $3, net.

This publication is compiled from a variety of reliable sources, including the *American Machinist*, *Grits and Grinds* and the *Transactions* of the American Society of Mechanical Engineers. While there may be some difference of opinion as to the relative values of the abstracts made, they are all valuable and show that good judgment and care were used in their selection.

If the reader of the book will bear in mind that it is made up of the opinions and practices of numerous firms, operators and demonstrators, he will readily understand why seeming contradictions occasionally occur. The very fact that the text is made up from such a variety of sources, makes the book more valuable and is one of its strongest features. As due credit is given in most cases, the reader is free to choose his own authority without involving the authors of the book.

The arrangement of the text is good. The illustrations are largely from line drawings and are well chosen to supplement the text. The first part of the book is devoted to what might be termed Manufacturing Grinding, with illustrations and description of the principal kinds of grinding machines. The last part of the book deals with the finer phases of grinding, such as tool and cutter work.

While the careful reader of the engineering, technical and trade press will find in the book little which is new to him, he must admit that to have the best of what he has read, gathered together in fine reference form, is well worth while. On the other hand, he who has read little about grinding will find the book a source of information and very suggestive. The reviewer feels that the subject of drill resharpening and the grinding of lathe, planer and boring-machine cutting tools should have received more space in the text. The increased production due to the proper grinding of these cutting tools would seem to warrant extra attention. The reviewer would also suggest that more might have been said relative to dry grinding in resharpening high-speed cutting tools. The interesting tests upon the bursting speeds of grinding wheels which have been made would be of value and these results might well have been included in this book.

The authors have, however, produced a book which should be owned and used by every grinding-machine operator as well as by superintendents and students of grinding.

SHOP MATHEMATICS — Part I: Shop Arithmetic. Prepared in the Extension Division of the University of Wisconsin. By Earle B. Norris, M. E., and Kenneth G. Smith, A. B., B. S. (Milwaukee), Associate Professors of Mechanical Engineering. New York and London: McGraw-Hill Book Co. Cloth; 6⅝x9½ in.; pp. xi + 187; 86 text figures. $1.50, net.

The authors have explained at length, and in words that a person with only an elementary knowledge of English should readily grasp, the fundamental conceptions and operations of simple arithmetical calculation. Particular attention is paid to giving full definitions and explanations of the terms and processes commonly used. While this involves a large amount of repetition and drilling on certain of the more elusive points, it is probable that this style of treatment is not only necessary but desirable, in view of the service for which the book is designed, namely, "to teach the fundamental principles of mathematics to shop men."

A noticable feature of the work and one which should prove attractive and also an aid to its success, is the fact that figures have been reduced in number to a minimum, so that in physical appearance a page is more like the "story of arithmetic" than the "statistics of arithmetic." A conversational tone seems to pervade the book, and this, in connection with the use of apt and clear references to common everyday applications of the subject, and with illustrations of familiar machines and devices, should convey to the student an idea of pleasure rather than of punishment.

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Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

THE BACTERIOLOGY OF SURFACE WATERS IN THE TROPICS—By Wm. Wesley Clemesha, M.D. (Vict.), D. P. H., Major, Indian Medical Service; Sanitary Commissioner, Bengal; Professor of Hygiene, Medical College, Calcutta; Late Officiating Sanitary Commissioner, Madras. Calcutta: Thacker, Spink & Co. London: E. & F. N. Spon, Ltd. Cloth; 5½x8¾ in.; pp. 161; numerous tables. Rs. ⅞.

CAISSON SICKNESS AND THE PHYSIOLOGY OF WORK IN COMPRESSED AIR—By Leonard Hill, M. B., F. R. S.; Lecturer on Physiology, London Hospital. London: Edward Arnold. New York: Longmans, Green & Co. Cloth; 5½x9 in.; pp. ix + 255; 66 text figures. $3, net.

DESCRIPTIVE GEOMETRY — In Six Parts. By William Calvin Hoover Slagle, C. E.; Assistant Professor of Descriptive Geometry and Drawing, University of Pennsylvania. New York and London: McGraw-Hill Book Co. Cloth [bound separately]; 6¼x9½ in. $6, net, per set.
Part I. Projections. Pp. 94; 76 text figures. $1.
Part II. Problems of the Point, Line and Plane. Pp. 142; 284 text figures. $1.50.
Part III. Warped Surfaces. Pp. 90; 35 text figures. $1.
Part IV. Shade and Shadows. Pp. 49; 38 text figures. 75c.
Part V. Isometric Drawing. Pp. 77; 74 text figures. 75c.
Part VI. Perspective. Pp. 95; 75 text figures. $1.

DIFFERENTIAL AND INTEGRAL CALCULUS—An Introductory Course for Colleges and Engineering Schools. By Lorrain S. Hurlburt, Collegiate Professor of Mathematics in the Johns Hopkins University. New York and London: Longmans, Green & Co. Cloth; 5½x8½ in.; pp. xviii + 481; illustrated. $2.25, net.

DIGEST OF WORKMEN'S COMPENSATION LAWS—A Reference Work for the Legislator, Lawyer, Insurance Expert, Employer and Employee. Prepared by The National Association of Manufacturers and The Manufacturers' Association of Connecticut. St. Louis, Mo.: Committee for Accident Prevention and Workmen's Compensation, 706 Locust St. Paper; 6x8¾ in.; pp. 55. 15c.

DON'TS FOR PLATELAYERS — Being Simple Hints on Track Maintenance. By A. J. Beaton, M. Inst. C. E., F. S. A., Scot.; Assistant Engineer-in-Chief, South African Railways. Pretoria: Government Printing Office. Paper; 3½x5¾ in.; pp. 23. (Printed in English and German.)

ELEMENTARY MACHINE DRAWING AND DESIGN—By William C. Marshall, M. E., C. E.; Assistant Professor of Machine Design, Sheffield Scientific School of Yale University; Formerly Assistant Professor of Descriptive Geometry and Drawing in S. S. S.; M. Am. Soc. M. E. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 320; 202 text illustrations. $3, net.

FIRST NATIONAL MINE-SAFETY DEMONSTRATION, Pittsburgh, Penn., Oct. 30 and 31, 1911—By Herbert M. Wilson and Albert H. Fay. With a Chapter on the Explosion at the Experimental Mine by George S. Rice. U. S. Department of the Interior Bureau of Mines [Joseph A. Holmes, Director]. Bulletin 44. Pub. Doc. Paper; 6x9 in.; pp. 75; illustrated.

GRAVITATION—By Frank Harris, B. A. Oxon.; Late Executive Engineer, and Assoc. M. Inst. C. E. New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. xi + 107; 18 text figures. $1, net.

ILLINOIS STATE GEOLOGICAL SURVEY—Bulletin No. 17. Portland-Cement Resources of Illinois. By A. V. Bleininger, E. F. Lines and F. E. Layman. [F. W. DeWolf, Director.] Urbana: University of Illinois. Cloth; 6x9¼ in.; pp. 121; 19 plates.

LIGHT, PHOTOMETRY AND ILLUMINATION—A Thoroughly Revised Edition of "Electrical Illuminating Engineering." By William Edward Barrows, Jr., B. S., E. E.; Professor of Electrical Engineering, University of Maine. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. ix + 335; 192 text figures; numerous tables. $3, net.

A MANUAL OF PHYSICAL MEASUREMENTS—By Anthony Zeleny, Ph. D., Professor of Physics, and Henry A. Erickson, Ph. D., Assistant Professor of Physics, University of Minnesota. Third edition. New York and London: McGraw-Hill Book Co. Cloth; 5x7¾ in.; pp. 248; 125 text figures. $1.50, net.

MECHANICAL ENGINEERING LABORATORY MANUAL—By Earl B. Smith, M. E.; Assistant Professor of Experimental Mechanical Engineering, Drexel Institute. Second Edition. Philadelphia: The Drexel Institute Press. Cloth; 6x9¼ in.; pp. iv + 92; 17 text figures. $2, postpaid.

MECHANISM — By Robert McArdle Keown, B. S., Assistant Professor of Machine Design, University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 169; 168 text figures. $2, net.

THE METALLOGRAPHY OF IRON AND STEEL—By Albert Sauveur, Professor of Metallurgy and Metallography in Harvard University. Cambridge, Mass.: Sauveur and Boylston. Cloth; 7¼x10¾ in.; pp. xv + 385; illustrated. $6, postpaid.

MILITARY HYGIENE AND SANITATION—By Col. Charles H. Melville, M. B. Edin., D. P. H.; Royal Army Medical Corps; Late Sanitary Officer, Army Headquarters, India. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 5½x9 in.; pp. 418; numerous tables and diagrams. $3.50, net.

MODERN ROAD CONSTRUCTION — A Practical Treatise for the Use of Engineers, Students, Members of Local Authorities, Etc. By Francis Wood, M. Inst. C. E., F. G. S., Borough Surveyor of Fulham [England]; Author of "Practical Sanitary Engineering." London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 5¼x8 in.; pp. xi + 137; two folding plates and 25 text figures. $1.50, net.

THE MOSQUITO: ITS RELATION TO DISEASE AND ITS EXTERMINATION—By Alvah H. Doty, M. D.; Formerly Health Officer of the Port of New York. New York and London: D. Appleton & Co. Cloth; 4½x6¼ in.; pp. 79; 11 illustrations.

PRELIMINARY STUDIES IN BRIDGE DESIGN—Being the first of a series of small volumes, each complete in itself, dealing with the design of ordinary highway bridges of moderate spans. By Reginald Ryves, Assoc. M. Inst. C. E., M. Assoc. Cons. Engrs.; Author of "The King's Highway, or the Nature, Purpose and Development of Roads and Road Systems." London: The St. Bride's Press, Ltd. Cloth; 5x7½ in.; pp. viii + 57; 33 text figures. 2/- net = 80c.

THE PRINCIPLES OF PARALLEL PROJECTING-LINE DRAWING—Part I of "The Theory of Engineering Drawing." By Alphonse A. Adler, B. S., M. E.; Instructor in Mechanical Drawing and Designing, Polytechnic Institute, Brooklyn, N. Y. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. vi + 66; 48 text figures. $1, net.

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